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REPORT ON THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) CONFERENCE ON FRAMEWORKS CONVERGENCE

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June 1991

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13. ABSTRACT (Maximum 200 words)

This paper reports on a conference sponsored by DARPA to address technical approaches and barriers to the convergence of Software Engineering Environment (SEE) frameworks. Several efforts currently specifying, designing, and/or implementing SEEs or SEE frameworks are proposing standards for tool interfaces and object management services. Potential conflicts have been thought to exist between some of these proposed standards. However, there is an emerging hypothesis that some approaches previously considered in conflict may in fact be complementary. It may be possible to develop standards that are "convergent" rather than competitive, in that they operate in conjunction with each other, or may be merged into single standards. Successful convergence would result in the simultaneous satisfaction of a broader range of tool and environment developer needs than can be satisfied by the standards individually, and thereby would broaden the applicability of these standards. This paper reports on the technical discussions of the conference as well as the agreements and conclusions reached by the participants.

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PREFACE

The purpose of this document is to summarize the discussions and conclusions of a conference held at the National Institute of Standards and Technology (NIST) in January 1991. The goal of the conference was to examine issues related to frameworks for Software Engineering Environments (SEEs), particularly potential convergence between different approaches for these frameworks.

The intended readers of this document are persons who are familiar with current trends in SEE frameworks, as well as with the critical issues related to Entity-Relation-Attribute (ERA) and Object-Oriented (O-O) object management systems. Although a brief background section summarizes many of these issues, this document will not serve as an introductory primer on these topics.

The preparation of these materials for publication was done by David Carney of the Institute for Defense Analyses (IDA). The conference chairman, Frank Belz of TRW, made significant improvements to the summary of the conference discussions, and also was the author of the conference Charter, much of which was abstracted into Section 3, "Background." In addition, Patricia Oberndorf of the Naval Air Development Center made valuable contributions to the final form of his document.

This paper was reviewed by the following members of IDA: Dr. Brian S. Cohen, Dr. Richard J. Ivanetich, Mr. Clyde G. Roby, Mr. David A. Wheeler, and Dr. Robert I. Winner.

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1. INTRODUCTION

On January 22-23, 1991, a meeting was held at NIST, in Gaithersburg, Maryland, under the sponsorship of the Software Technology for Adaptable, Reliable Systems (STARS) program of the Defense Advanced Research Projects Agency (DARPA). The meeting was convened as a result of a joint planning activity in the fall of 1990, when representatives of the STARS Prime contractors and the STARS Program office agreed that the program would begin selecting its standards in early 1991. These standards will be used in three prototype SEEs that are being integrated by the STARS Primes. The outstanding issue for the program is the degree either of compatibility or variance between several of the standards under consideration. At the very least, there is an apparent divergence between some candidate standards that may be critical to the STARS goal of an open architecture framework across the three Primes.

The purpose of the meeting was therefore to establish whether it is technically feasible, within the STARS timeframe of 1991-1993, to converge existing, apparently competing, approaches to SEE frameworks as reflected in certain proposed interface standards. Such convergence, if technically feasible, could improve the prospects for marketplace acceptance of these approaches, and thereby speed the process of developing SEEs, especially including STARS SEEs. Central to the question of such convergence was the matter of how those frameworks standards that are either ERA frameworks and O-O frameworks could interrelate, either within or between instances of a STARS SEE.

Attendees

Participants in this meeting included representatives of government, commercial application and environment developers, and Department of Defense (DoD) contractors. The following persons were in attendance:

Administrative:

Frank Belz, TRW, Chair
David Carney, Institute for Defense Analyses, Recorder

STARS:

Ed Cuoco, Digital Equipment Corporation (DEC)
David Goiffon, Unisys
Bob Ekman, IBM/Gaithersburg
William Hodges, Boeing
Mansour Kavianpour, IBM/Toronto
John Kramer, DARPA/STARS
Bob Munck, Unisys/Reston

Other attendees:

Robert Balzer, USC/ISI
Hugh Beyer, DEC
Eric Black, Atherton Technology
Currie Colket, Ada Joint Program Office
Herman Fischer, Mark V Systems
Regis Minot, GIE Emeraude
Patricia Oberndorf, Naval Air Development Center
Gary Pritchett, SofTech/San Diego
Andres Rudmik, Software Productivity Solutions, Inc.
Ian Thomas, Hewlett-Packard
William Wong, NIST

Chris Nolan, DEC/Varese, Italy, was also invited to attend the Conference but was unable to attend.

[At the start of the meeting, each participant gave a brief self-introduction, with a brief history of relevant personal activities, which are summarized in Appendix B.]

The contents of the document include Section 2, a brief introductory section that describes the technical issues of the conference; Section 3, a description of the immediate background of the conference; Section 4, a summary of the conference discussions; Section 5, which details the conclusions, actions, and agreements of the conference; and several appendices that include the minutes of the conference as well as a transcript of the summary statement made by the conference chairman.

2. BACKGROUND

Several efforts currently specifying, designing, and/or implementing SEEs or SEE frameworks are also proposing standards for tool interfaces and object management services. These efforts often have overlapping goals, and as a consequence, have proposed standards that appear to be in conflict. Numerous attempts to evaluate the current developments and future trends in such interfaces have been conducted in recent years and are continuing. Interactions among developers and evaluators have surfaced an emerging hypothesis that some approaches, previously considered essentially in conflict, may in fact be complementary. Consequently, it may be p ssible to develop standards that are "convergent" rather than competitive, in that they operate in conjunction with each other or may be merged into single standards encompassing and replacing the complementary standards.

Currently, numerous framework standards are competing for acceptance, none of which addresses satisfactorily all the problems facing environment and tool developers. This situation makes it extremely difficult for tool developers to determine which platforms are worthy of (re)hosting their tools. Consequently, it is difficult for framework developers to demonstrate the efficacy of their approach with respect to existing tools. The causes of this situation are self-perpetuating—it takes so long to demonstrate adequacy of new frameworks that alternate approaches arise and undercut the motivation to commit to the original frameworks.

Successful convergence would result in the simultaneous satisfaction of a broader range of tool and environment developer needs than can be satisfied by the contributory standards individually, and thereby would broaden the applicability of the contributory standards. This in turn, could clarify the marketplace opportunities for tool developers, and provide growth paths for framework and environment developers. For these results to occur, it will be necessary to establish satisfactory understanding of the relationship between the convergent standards and the architectures of conforming environments. Determining that there exist viable architectures that gain the benefits promised by convergence is one of the major technical tasks in a convergence effort.

3. SUMMARY OF THE CONFERENCE DISCUSSIONS

The fundamental problem of frameworks convergence is one of providing multiple interfaces that can access a common repository. If one interface is O-O in nature and another interface is ERA in nature, there is a question as to whether and how much commonality can be achieved. The principal topics for the Conference were therefore possibilities and strategies for achieving convergence between these two types of interface.

3.1 Focus of the Convergence Effort

There are several efforts currently underway that use one of these interface types. Among the most significant are the Portable Common Tool Environment (PCTE, based on an ERA model), the Common Ada Programming Support Environment Interface Set, Revision A (CAIS-A, also based on an ERA model), A Tool Integration Standard (ATIS, based on an O-O model), and a new initiative called the Portable Common Interface Set (PCIS) which originated as an attempt to bridge the differences between PCTE and CAIS- A. Of these, PCTE and ATIS have received significant attention in the commercial sphere, and were the two interface efforts that were discussed most during the conference. Several attempts have been made to converge these two interfaces.

One initial question for the conference was whether a convergence exercise focusing mainly on PCTE and ATIS is appropriate. In other words, convergence between ERA and O-O strategies in general is not synonymous with convergence between PCTE and ATIS as representatives of those strategies. Almost without exception, for instance, any statement made about convergence that uses "PCTE" could be recast using "CAIS", and the statement would prove equally accurate. In the same manner, although the PCIS effort is still in its formative stages, it may result in a standard that is an evolution of current ERA technology. Discussion of convergence strategies should possibly be widened to include this effort. Even further, it could be argued that frameworks convergence should not be restricted only to ERA and O-O notions: conceivably convergence should embrace items such as the UNIX file system as well.

During the Conference, however, the statements of most participants implied that the convergence exercise is intimately related to the current situation in the CASE community, wherein the only commercially viable ERA solution is PCTE. Thus for STARS, an ERA convergence exercise is basically a PCTE convergence exercise. Similarly, though much work is being done in Cbject-Oriented technology, ATIS is the O-O effort that has gained the most commercial momentum at the present time. STARS will observe and support the ongoing PCIS effort, since that is potentially a vehicle for frameworks convergence. It is unlikely, however, that a PCIS implementation will be in existence within the STARS timeframe.

3.2 High-Level Approaches to Convergence

The Conference first examined four high-level approaches in converging PCTE and ATIS: a dual interface approach, a central interface approach, an approach with multiple levels of interface (called the "wedding cake" approach), and an approach that relies on logically common infrastructure.

3.2.1 Dual Interface Approach

The basis for this section was Hugh Beyer's report on the activities of the DEC group at Varese, Italy. Their approach amounts to building a database on one type, and providing a mapping to interfaces of the other type. The DEC group tried this by building an object-oriented database, and then constructing a set of ATIS interfaces and a set of PCTE interfaces (actually subsets of ATIS and PCTE respectively) on top of it. The PCTE interface implementation was in terms of method dispatches driven by the O-O database; in order to do this, however, the underlying model needed semantics that were not available in ATIS (see Figure 1). This experiment demonstrated, to DEC's satisfaction, that PCTE and ATIS could share the same object base.

It is also possible to reverse this approach and to build over an ERA database (see Figure 2). The DEC/Varese group began their exercise by trying to use this approach, but they could not achieve a workable solution. They concluded that the underlying repository needs to be an O-O, and not an ERA base.

3.2.2 Central Repository Approach

The basis for this section was David Goiffon's report on current activities at Unisys. In order to determine whether PCTE, ATIS or some other framework would be an appropriate basis for repository services for Unisys tool capabilities, a Unisys team set about to define a central interface that satisfied the needs of those capabilities, and then posed the question, "Which of these platforms is adequate to implement the central interfacc?" (See Figure 3.)

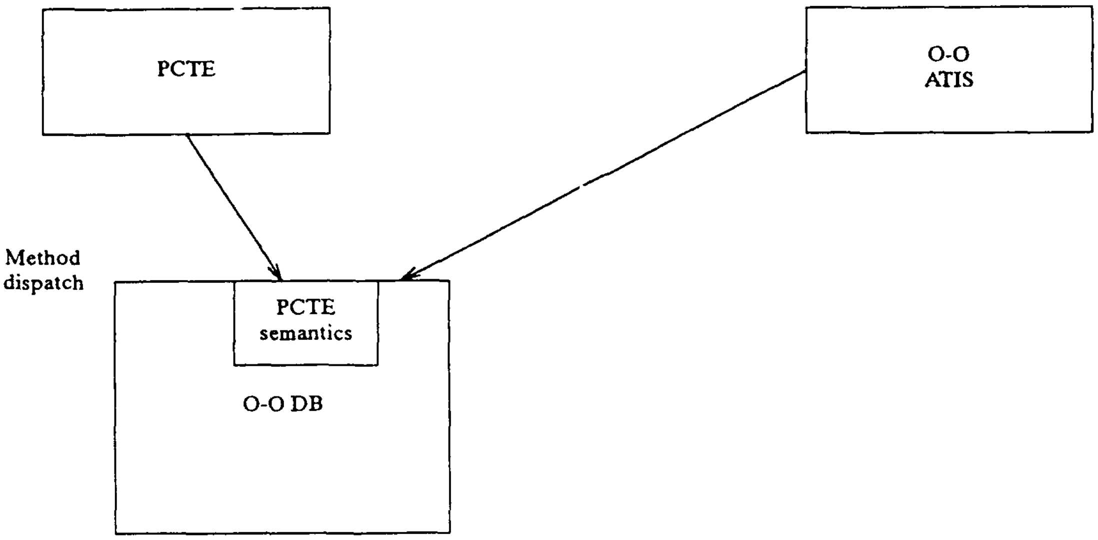


Figure 1. Dual Interface Model on O-O

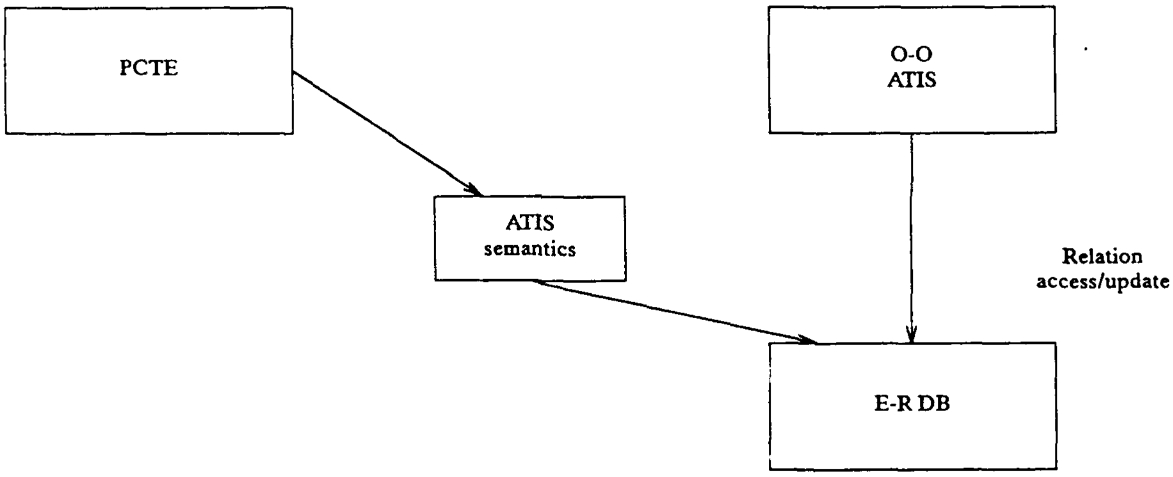


Figure 2. Dual Interface Model on ER

The specific services required at the central interface were determined on the basis of scenarios derived from the usage of three different kinds of customers: 3GL users (oldest, most sizable customers), 4GL users (largest number of customers), and Object-oriented language users (target customers to be served by future Unisys tools). The team's conclusion was that the facilities required at the central interface could not be supplied by either PCTE or ATIS alone.

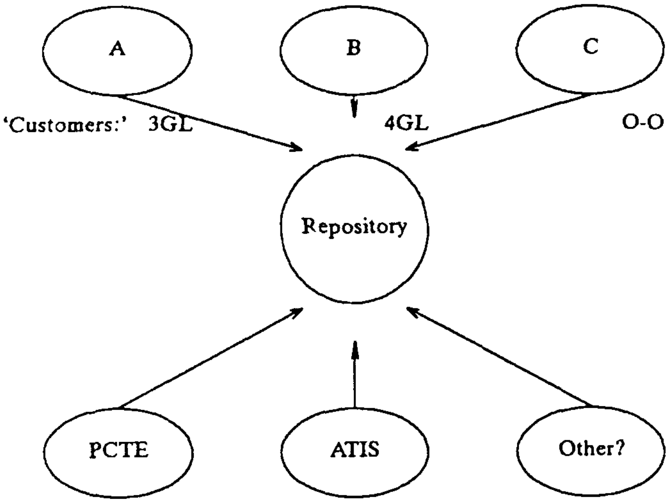


Figure 3. Central Repository Model

3.2.3 "Wedding-Cake" Approach

The basis for this section was a report by Regis Minot, from GIE Emeraude A different approach is to present numerous levels of different interfaces. In this approach, tools may have access to various levels as necessary to be integrated into the system (see Figure 4).

Thus, "foreign" tools (e.g., tools that are neither PCTE nor ATIS) could reside on a visible POSIX interface, PCTE-only tools on a PCTE interface, ATIS tools on a set of object-oriented common services, and some tools could conceivably require both O-O services as well as ERA services. It should be noted that one element of this version, where ATIS tools reside on a set of common services, is essentially a thing that the DEC/Varese team tried unsuccessfully.

In this approach, there is minimal support for interoperation of tools. Among the missing necessities for tool interoperation are shared logical schemata, which can be expressed either in a class hierarchy, or in an ERA model. Some such schema is needed. Thus, while this approach leads to putting different tools into the same system, it does not go very far toward achieving interoperation.

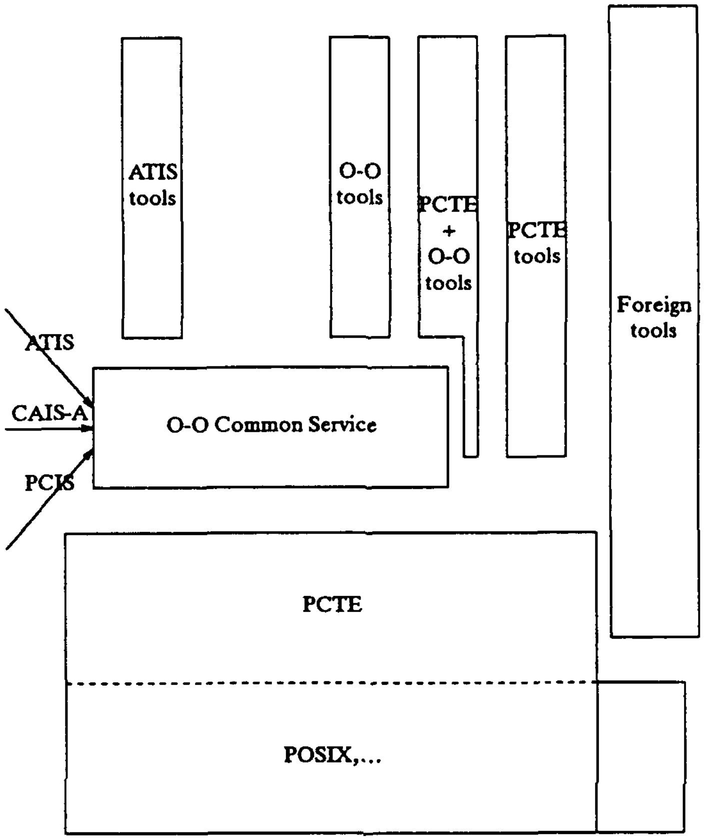


Figure 4. 'Wedding Cake' Model

3.2.4 Logically Common Infrastructure Approach

The basis for this section was a presentation by Andres Rudmik of the CIS Consortium This approach differs from the prior ones in that it focusses upon matters of policy. It is also based on the observation that there is a disparity in the degree to which certain policy issues have been addressed in the underlying infrastructure of ATIS and PCTE. Such infrastucture elements include mechanisms realizing notions of process and transactions, versions and configurations, security, access controls, and views.

The approach is to determine abstract descriptions or models of policy and mechanism in order to realize, for example, versioning support, and to use these as the basis for achieving logically common infrastructure in the tools. This common infrastructure is made real by being mapped to the different mechanisms provided by the alternative platforms (see Figure 5).

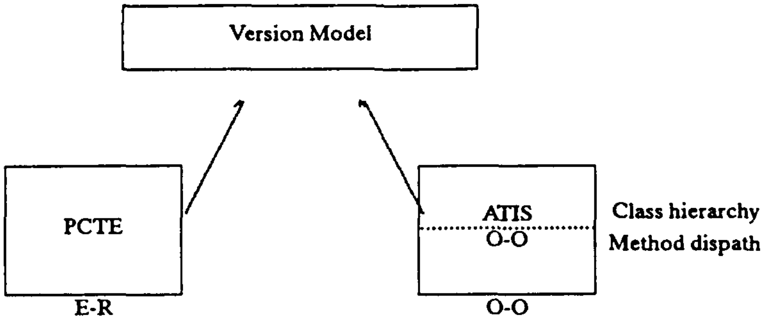


Figure 5. Common Infrastructure Model

This approach may be especially helpful in those areas where the ATIS specification is incomplete with respect to mechanisms to support such infrastructure. The approach may provide guidance on how to define the missing ATIS mechanisms. Or where alternative, incompatible mechanisms exist for PCTE and ATIS, it may assist in the definition of alternate class hierarchies in the ATIS model to support the realization of such common infrastructures.

3.3 Brainstorming Exercise On Critical Issues In Frameworks Convergence

A major goal of the Conference was to determine specific strategies, both short- and long-term, that might facilitate frameworks convergence. To that end, a 'brainstorming' exercise was conducted in which the participants each suggested ideas, either in the form of goals, strategies, or merely statements of fact, believed to be key issues related to the problem of achieving convergence. The goal of this exercise was to identify consensus on which issues were most critical.

The output of the brainstorming was a list of 45 items. Some were in the nature of statements, others were possible strategies for convergence. As these were discussed and compared, it was immediately obvious that there existed a wide spectrum of focus and scope among them. The participants noted that this made comparing suggestions difficult, but also that comparing "different-in-kind" issues was inevitable, given the nature of the problem and the needs of the STARS program. The participants did determine, however, that the suggestions tended to fall into four broad (sometimes overlapping) categories.

1. Framework requirements
2. Technical approaches, including whether monolithic standards or fragmented subsets of standards are preferable
3. Management approaches to frameworks standards development
4. Definition oi the market place, i.e., "Who is it that is influenced by the convergence, and hcw does that influence matter in the convergence process?"

3.3.1 Refinement of Technical Issues

In order to refine this large list, complementary items were merged. Then, to discover whcther the Conference as a whole had any shared sense of priorities, a vote was taken on the criticality of each item. The results of this process indicated a general agreement that out of the original 45, four key issues were most significant. In the order of priority, the issues are as follows:

1. O-O capabilities with PCTE

2. Useful union of existing standards

3. Know the intended beneficiaries of convergence

4. Approaches to logical schema

Of these, the first two fall under the "Technical Approach" category, the third in the "Target Market" category, and the fourth was considered to be in both the "Technical Approach" and the "Framework Requirements" categories. In the voting on criticality of these four issues, the first (O-O capabilities with PCTE) was chosen by a wide margin as the most important. The other three were considered to be approximately equal in criticality. No issue in the "Management approaches" category received a large number of votes.

3.3.1.1 O-O Capabilities with PCTE

This key issue is a merger of three slightly different suggestions:

1. "Given that PCTE is standardized and ATIS is in a formative stage, start with PCTE interface and find a new object-oriented view that has PCTE in mind (instead of the object-oriented view that has UNIX in mind, like ATIS is)."

2. "Design an object-oriented layer that is a common service on top of ECMA/PCTE. It should satisfy object-oriented requirements that have been identified for these systems (in particular ATIS and PCIS)."

3. "Develop object-oriented interface support services on top of PCTE which both complements PCTE and has no unnecessary changes to ATIS."

These three items indicated a widespread desire to explore the relationship between O-O mechanisms and the PCTE mechanism. The precise *nature* of the relationship, whether simple coexistence or a predominance of one view over another, remains to be seen.

3.3.1.2 Useful Union of Existing Standards

This key issue was a merger of two other suggestions:

1. "Achieve frameworks convergence by defining the 'useful union' of CAIS, PCTE, ATIS (and perhaps other frameworks). 'Useful union' is defined as taking the *intersection* of the existing standards, then adding in some desirable features that now exist in some of them."

2. "Don't feel compelled to take various standards in their entirety; it is possible to take a meaningful necessary subset."

This suggestion is targeted at finding the minimum necessary means to achieve the required capabilities of converged interfaces.

3.3.2 Know the intended beneficiaries of convergence

This key issue was the result of five suggestions:

1. "Exploit the fact that tool-writers (not tool-users) are the marketplace for (beneficiaries of) convergence."
2. "Exploit the fact that tool-users (not tool-writers) are the marketplace for (beneficiaries of) convergence."
3. "Resolve the question: Who are we trying to satisfy?"
4. "Exploit the concept that the ultimate benefactors of frameworks convergence are application developers."
5. "Understand if and how O-O database vendors have a place in the result of this process."

Some of these are contradictory; in particular, the first and second items in the above list. What is true about all of these statements, however, is that they suggest that the beneficiaries of frameworks convergence need to be known, since this knowledge will have an impact on the exercise of achieving it. The encompassing notion of this composite strategy is "Determine what is currently happening with tool development, what that implies in regards to the requirements on frameworks, and how that impacts convergence."

3.3.3 Approaches to Logical Schema

This issue was a merger of two other suggestions:

- "Include schema definition in the process of convergence."
- "Find common schema for these two systems (PCTE and ATIS), since it is still possible to do so."

[See Appendix D for a full listing of all of the issues that were enumerated at the Conference, together with the itemized vote counts for each.]

4. CONSOLIDATED GOALS, STRATEGIES, AND ACTIONS FOR ACHIEVING CONVERGENCE

Following the "brainstorming" exercise, the participants consolidated the previous discussions. Consolidation was done first by examining the sometimes conflicting *goals* of convergence that had been implied in the discussion. They then agreed on a list of actions, a list of consensus items (e.g., ones that all participants had agreed to), and a list of unresolved issues.

4.1 Goals of the Convergence Exercise

Most of the positions that had been stated during the Conference were based on an implicit sense of the goal of frameworks convergence; e.g., "why are we doing this exercise?" Since some of the positions were in conflict, the goals that supported those positions were examined and contrasted. One benefit of this was to put the long list of suggested issues into some perspective. It also served to expose other issues related to short-term and long-term strategies.[1]

Possible goals of frameworks convergence include:

Goal To achieve a new, monolithic, aggregate standard.

Goa! To retain both Object-Oriented and Entity-Relationship "sides", but to achieve interoperability of the sort where the capabilities running on the Object-Oriented side and the capabilities running on the ERA side dynamically share data.

Goal To achieve data sharing only before and after the execution of units of activity (a restricted form of ii).

Goal Continued existence of multiple frameworks, adding support to make porting tools from one framework to another easier and less costly (minimal convergence).

[1] The bases for this section were presentations by Bob Balzer of USC/ISI and Ian Thomas of Hewlett-Packard.

Goal To have *independent but compatible* standards. Inherent in this is both the notion of "profiles", as sets of harmonized standards, and the assumption that existing standards can be subdivided into compatible pieces.

Goal To reduce distance between existing standards by extending them toward each other.

Goal To have several *complementary* standards (similar to the fifth goal).

4.1.1 Comparison of Goals

In comparing the relative merits of these goals, discussion touched on some inherent difficulties in each. In particular, for any of the alternative goals that implied layering PCTE and ATIS, services such as object management or process management necessitate that some choices must be made at one level that will constrain other choices at another level. It may be difficult to harmonize such choices between PCTE and ATIS. One hypothesis, that the various issues of convergence could be approached incrementally, with specific tactics for distinct sets of issues, was countered with the contrary hypothesis that the substructures of such interfaces are necessarily highly cohesive, and are not easily separable nor recombinable.

It was noted that the second goal, retaining both O-O and ER "sides," may require more substantial convergence in order to satisfy the requirement for interaction, compared to that required to the third goal, which merely requires "batch" oriented interoperation. Also, for the fourth goal, trying to reduce porting costs, the task at the present of reworking a tool from ATIS to PCTE involved reworking interfaces (easy), data models (harder), and control models (maybe impossible).

4.2 Agreements Reached At The Conference

The participants of the Conference reached agreement on nine items.

Agreement 1. O-O methods and technology should be provided and supported; the original consensus was for O-O support in *environments*, but this was later changed to support in *frameworks*. *NB: This change in focus did not receive unanimous support.* A key point in this agreement was that emphasis is on O-O technology because it solves real software engineering problems and is not just a technology fad.

Agreement 2. Itemize several recommended areas where individual mechanisms for commonality between ATIS and PCTE could be found. These included schema, definitions of types of methods (with possible concern of granularity), versioning, transactions, distribution of data security, multiple use, multiple schema, and multiple inheritance.

Agreement 3. The third and fourth agreements were actually statements rather than agreements: the third states that because ATIS is in a much earlier stage of its evolution, it is therefore more malleable, and also more incomplete.

Agreement 4. The fourth agreement states that the PCIS activity is the probable avenue for evolution of PCTE. Action items were issued for both statements.

Agreement 5. The fifth agreement, also in the form of a statement, is an observation that there is no appropriate place in the standards community fo· addressing framework issues.

Agreement 6. The problems of commonality of schemata, and of commonality of types and methods are important, very hard to achieve, and very critical for STARS to begin addressing.

Agreement 7. STARS should be working to assure that divergence, whether perceived or actual, between PCTE and ATIS should not be *exaggerated* by a convergence exercise.

The last two points of agreement were, in fact, only partially agreed to by all. However, it was asserted that it is possible in ATIS to separate the class hierarchy component from the dispatch mechanism component of object oriented interface mechanisms (such as in ATIS), and that there was value in first doing so, and then addressing the relationship between the dispatch mechanism and the control binding mechanism in PCTE. At least the vendors that were attending the Conference who are making investments in this area are exploring that strategy.

4.3 Action Items From The Conference

The participants of the Conference suggested seven action items to STARS.

Action Item 1. STARS should find a vehicle for participating in the exercise of finding a method dispatch mechanism that is compatible with PCTE. STARS should encourage the convergence of these, thereby possibly minimizing the distance between that result and ATIS

Action Item 2. STARS must identify a process for resolving unresolved issues raised in this meeting (cf. Section 5 below).

Action Item 3. With regard to the second item, STARS should establish a process to analyze similarities and differences between PCTE and ATIS, and identify possible reconciliations. Very early steps of such analysis have been suggested in this meeting. The identification of possible reconciliations is an urgent item if it is to have a positive effect. Clear commitment by STARS on the convergence issue must exist by June; this requires at least the analysis to be completed.

Action Item 4. STARS (and other interested parties) should stimulate the establishment of a home in the standards world for framework standardization issues.

Action Item 5. To address Agreement 7, STARS should exert leverage in *both* the PCTE evolution (e.g., PCIS) and ATIS evolution communities (e.g., the CASE Integration Services Consortium).

Action Item 6. STARS should implement the following:

a. Include user scenario work revealed here (i.e., the Unisys work leading to the central interface approach above) in the STARS Process activities.

b. Use the process work carried on within STARS to guide and influence STARS' framework decisions

c. Determine which client community is most impacted by convergence concerns, and then determine how to exploit this knowledge in defining the steps of the convergence process. (This action is based on "brainstorming" items 8, 10, 14, 21, and 37

Action Item 7. STARS should define a relationship with the PCIS activity, and should determine the means for using that relationship to achieve Actions 1-6

4.4 Unresolved Issues

The participants of the Conference discussed the following items, but failed to reach significant agreements concerning them. These items are:

a. How much convergence is actually necessary if STARS is to achieve the anticipated benefits to tool construction and interoperation.

b. Whether or not STARS should base framework evolution on ECMA/PCTE, i.e., whether or not to view the introduction of O-O capabilities as "value-added" to the existing PCTE proposed standard.

c. Whether or not STARS should base framework evolution on UNIX, i.e., whether or not to view the introduction of O-O capabilities as "value-added"to UNIX (or, better, POSIX).

d. Whether STARS should investigate successful interoperability exercises that have been done in the heterogenous database community.

e. Whether STARS should embrace monolithic versus partitionable standards.

ACRONYMS

APSE	Ada Programming Support Environment
ATIS	A Tool Integration Standard
CAIS	Common Ada Programming Support Environment Interface Set
CASE	Computer-Assisted Software Engineering
CIS	CASE Integration Services
CPL	Common Prototyping Language
COTS	Commercial off the Shelf
DARPA	Defense Advanced Research Project Agency
DoD	Department of Defense
ECMA	European Computer Manufacturers' Association
EIS	Engineering Information System
ER	Entity-Relationship
ERA	Entity-Relationship-Attribute
IDA	Institute for Defense Analyses
IRDS	Information Resource Dictionary System
ISEE	Integrated Software Engineering Environment
ISTO	Information Science and Technical Office
KAPSE	Kernel Ada Programming Support Environment
KIT	KAPSE Interface Team
KITIA	KAPSE Interface Team with Industry & Academia
MCCR	Mission-Critical Computer Resources
MLS	Multilevel Security
NFS	National File System
NGCR	Next Generation Computing Resources
NIST	National Institute for Standards and Technology
O-O	Object-Oriented
OODB	Object-Oriented Database
OOISS	Object-Oriented Interface Support Services

OSF	Open Software Foundation
PC	Personal Computer
PCIS	Portable Common Interface Set
PCTE	Portable Common Tool Environment
POSIX	Portable Operating System Interface for a Computer Environment
SEE	Software Engineering Environment
SQL	Structured Query Language
STARS	Software Technology for Adaptable, Reliable Systems
SWG	Software Working Group

APPENDIX A

CHARTER OF THE FRAMEWORKS CONVERGENCE MEETING

Meeting on Convergence of Frameworks for Software Engineering Environments

January 22-23, 1991

On January 22-23, 1991, a meeting on the possible convergence of commercial frameworks for Software Engineering Environments will be hosted by the National Institute for Standards and Technology in Gaithersburg, Maryland, under the sponsorship of the Defense Advanced Research Projects Agency, Software Technology for Adaptable, Reliable Systems (STARS) Program. The meeting is being held with the expectation that it will produce a sharper understanding of the Software Engineering Environment (SEE) framework options that are available to STARS.

The purpose of the meeting will be to establish whether it is technically feasible, within the STARS timeframe of 1991-1993, to converge existing, apparently competing, approaches to SEE frameworks as reflected in proposed interface standards. Such convergence, if it is technically feasible, could improve the prospects for marketplace acceptance of these approaches, and thereby speed the process of developing SEEs, especially including STARS SEEs. Of particular technical concern is the apparent competition between framework approaches based on ER models (for example, ECMA/PCTE and CAIS-A) and those based on Object Oriented models (for example, ATIS), and the potential for converging these approaches.

The meeting will be by invitation only, and members of government, academia and industry (both commercial and DoD contractor industry) representing major efforts to accelerate the emergence and acceptance of viable SEEs. Programs with particular concern in this area include:

- The Next Generation Computer Resources (NGCR) Program
- The STARS Program
- ECMA/PCTE Programs
- CAIS-A (MIL-STD 1838A) related programs
- The Portable Common Interface Set (PCIS) Programme
- The National Institute of Standards and Technology ISEE activity.

A few other individuals will also be invited.

While each of the programs listed has particular interest in the goals of this meeting, the STARS program depends most urgently on its results and will be the principal consumer of its products. Following is a more detailed description of the background leading to the meeting, the objectives of the meeting, and the results that are anticipated.

1. BACKGROUND

1.1 SEE Framework Efforts

Several efforts currently specifying, designing, and/or implementing Software Engineering Environments (SEEs) or SEE frameworks are also proposing standards for tool interfaces and object management services. These efforts often have overlapping goals, and as a consequence have proposed standards that appear to be in conflict. Numerous attempts to evaluate the current developments and future trends in such interfaces have been conducted in recent years and are continuing. Interactions among developers and evaluators have surfaced an emerging hypothesis that some approaches, previously considered essentially in conflict, may in fact be complementary. Consequently, it may be possible to develop standards that are "convergent" rather than competitive, in that they operate in conjunction with each other, or may be merged into single standards encompassing and replacing the complementary standards.

1.2 Potential Impact Of Convergence On Tool And Framework Developers

Currently, numerous framework standards are competing for acceptance, none of which addresses satisfactorily all the problems facing environment and tool developers. This situation makes it extremely difficult for tool developers to determine which platforms are worthy of (re)hosting their tools. Consequently, it is difficult for framework developers to demonstrate the efficacy of their approach with respect to existing tools. The causes of this situation are self-perpetuating – it takes so long to demonstrate adequacy of new frameworks that alternate approaches arise and undercut the motivation to commit to the original frameworks.

Successful convergence would result in the simultaneous satisfaction of a broader range of tool and environment developer needs than can be satisfied by the contributory standards individually, and thereby would broaden the applicability of the contributory standards. This in turn, could clarify the marketplace opportunities for tool developers, and provide growth paths for framework and environment developers. For these results to occur, it will be necessary to establish satisfactory understanding of the relationship between the convergent standards and the architectures of conforming environments. Determining that there exist viable architectures that gain the benefits promised by convergence is one of the major technical tasks in a convergence effort.

1.3 STARS

The STARS Program is presently choosing a set of noncompeting standards for use as the basis of an open architecture framework. This framework will be the basis for several domain-specific Software Engineering Environments (SEEs) that will be used by various DoD agencies to implement mission-critical software projects. To the greatest extent possible, these SEEs will be populated by commercial, off-the-shelf (COTS) software. The STARS SEEs are planned to be in use starting in 1993 and thus it is vital that the standards selected by STARS have the greatest chance of gaining wide currency, particularly in the commercial marketplace.

1.4 Potential Impact Of Framework Convergence On STARS

If standards that are candidates for selection by STARS are in essential conflict, STARS may be forced to make an early choice among the competitors. Subsequently, the degree of success that the selected standards achieve in the competitive commercial environment marketplace (largely reflected by the number and variety of the tools developed to work on these standards) may then determine the success of STARS SEEs.

If certain key standards can be made "convergent" and do not thereby lose stature in the commercial marketplace competition, then an important risk in the STARS SEE program would be significantly reduced. STARS may not need to make such early choices, since STARS SEE architectures could be based on multiple standards and the implementation of such architectures could be coordinated with the evolution of implementations supporting those standards. For this benefit to actually be realized, any required adaptations of the standards to become convergent would have to be achieved in the near future (perhaps within a year), and the commitment to achieve such convergence would need to be made in the next few months.

2. PURPOSE OF THIS MEETING

The purpose of the meeting will be to establish whether or not it is technically feasible to converge existing, apparently competing, approaches to Software Engineering Environment (SEE) frameworks as reflected in proposed interface standards. Of particular technical concern is the apparent competition between framework approaches based on ER models (for example, ECMA/PCTE and CAIS-A) and those based on Object Oriented models (for example, ATIS), and the potential for converging these approacl.es. The areas in which these approaches differ are perceived by some observers as the central opportunities for convergence, and will be, at least initially, the focus of the meeting. These areas include:

- Data model: eg, ERA vs. O-O;
- Granularity: eg, "files" vs. bits, interactions per day, minute, second, millisecond;
- Access control: eg, MLS, Discretionary access control, unconstrained access;
- Process control: eg, Interprocess Control and Communication, etc.;
- Change control: eg, object locking, transaction management (long-term, short-term, nested, etc.);
- Others to be identified.

There are several specific objectives for this meeting:

1. Identify the ways (if any) in which the hypothesized potential for convergence is well-founded among the set of efforts represented by thc attendces. This objective is to be achieved on technical grounds: if there is no technical basis for convergence, an economic/political basis would probably not arise, and would certainly be insufficient if it did.
2. Identify whether or not special actions will be required in order to achieve convergence. Such special actions might include specific accommodations on the part of some efforts, or o.her community actions that may go beyond the represented efforts. If such actions are required, identify alternate approaches to achieving them.
3. Identify the degree to which there is interest among key parties to achieve convergence.

Of these objectives, the first is primary. Initial approximations to the others are sufficient for this meeting.

3. RESULTS

The meeting will have both tangible and intangible results:

3.1 Report

The minutes and decisions of the meetings will be distributed for comment by the invited members on or before February 15, 1991. Thereafter the minutes and decisions of the meetings will be published and disseminated by IDA for use by STARS and other concerned Governmeni agencies.

3.2 Consensus/Roles

The meeting will help to establish the degree to which there is technical consensus on the convergence hypothesis. In addition, it may clarify the possible involvement in the STARS program of one, some, or all of the efforts represented.

APPENDIX B

CAPSULE BIOGRAPH'ES OF PARTICIPANTS

Robert Balzer, USC/ISI:

is currently working on the DARPA CPL project; has worked extensively with frameworks issues.

Frank Belz, TRW (Chair):

is TRW Technical Fellow; has been involved in environment activities since late 70's; is currently a co-PI on DARPA's Arcadia and Common Prototyping System programs; will serve as a PCIS "Expert".

Hugh Beyer, DEC:

has been involved in standards work for the last 5 years; is currently involved in ATIS work and repository development projects.

Eric Black, Atherton Technology:

is Principle Architect of the Software Backplane commercial product of Atherton; noted that PCTE and ATIS convergence is desirable (to Atherton) for obvious commercial reasons.

David Carney, IDA:

is currently chair of the STARS working group preparing the Requirements and Criteria and Open Architecture Framework for the STARS SEE.

Currie Colket, AJPO:

is currently Deputy of the Ada Joint Program Office working for the NATO SWG/APSE program and also for the PCIS effort; pointed out that the PCIS standard will be more than convergence of CAIS-A and PCTE+, and that the PCIS effort is interested in a commercial standard that platform vendors will support.

Ed Cuoco, DEC:

is the Business Manager for DEC's Cohesion *program; added a statement concerning DEC's goal of providing products which satisfy its customers.*

Bob Ekman, IBM:

is deputy architect for the IBM STARS project; is currently on the working group that is establishing an Open Architecture Framework and Requirements and Criteria for STARS SEE.

Herman Fischer, Mark V Systems:

is Chairman of Mark V Systems, Limited; has worked with issues related to frameworks and environments since the CAIS/KIT/KITIA.

David Goiffon, Unisys:

is manager of the Unisys Repository Group, and is also the Architect of Unisys Repository; noted that there is a interest in using frameworks throughout Unisys.

William Hodges, Boeing:

is Program Manager for the Boeing STARS program; pointed out the need to be cognizant of the requirements of the end user.

Mansour Kavianpour, IBM:

is currently working on the AIX CASE environment, and is architect of the AIX Repository Manager.

John Kramer, DARPA/STARS:

is director of the STARS Program, and has been involved in frameworks and environments activities from the inception of the CAIS/KIT/KITIA.

Regis Minot, GIE Emeraude:

is a designer of PCTE, and has been involved with the program since its inception; also offered to supply any needed information on the status of the Emeraude implementation of PCTE.

Bob Munck, Unisys:

is Deputy Architect for the Unisys STARS program; represents a large body of experience in CAIS-A, and on on frameworks issues in general.

Patricia Oberndorf, NADC:

has worked on environments for fifteen years, in particular leading CAIS through its development; is now establishing Navy interface standards, including those for the Next Generation Computer Resources/Project Support Environments.

Gary Pritchett, SofTech:

is currently manager of the SofTech CAIS-A project sponsored by the Ada Joint Program Office; program has defined CAIS-A, as well as producing both VAX & UNIX implementations of CAIS-A.

Andres Rudmik, Software Productivity Solutions:

is chairman of the CASE Integration Services (CIS) Consortium; is also currently doing Air Force work on concurrent engineering.

Ian Thomas, Hewlett-Packard:

is Software Engineer in the Engineering Systems Division, and worked with Bull from 1986-1989 on PCTE; is currently working on the HP Softbench project, and expressly considering evolutions of Softbench in the context of PCTE.

William Wong, NIST:

is working on the NIST Software Environment Program, developing documentation on the area of software environments to be issued as a FIP; noted that the PCTE and ECMA Reference Model activities will be important for refining the eventual NIST documents.

APPENDIX C

TRANSCRIPT OF THE CHAIRMAN'S SUMMARY OF THE MEETING

Frank Belz:

I have been through an interesting process and this part of the process is basically for us as a group to review with those of you from STARS and ISTO who are here now what's just happened. So I want to cover a little bit of the process to let you know the structure that we went through. And most of you (not Teri Payton) have been sitting through the last phase of what we did. So I want to catch you up on what happened previous to that very quickly.

During the first part of the meeting, we basically did information-sharing to establish a context. So several people volunteered to get up and talk about what their work was, and how it related to the issue of convergence. The result of that was a bunch of papers which are part of the repository or is available and, I suspect, will migrate to whoever needs to have [them] in STARS.

After that, we heard from some people who have already been doing some experiments in convergence of object-oriented capabilities in the context of PCTE convergence; there were different strategies described. There were several discussions that evolved from those presentations. After that we did some other activities, and this morning Bob Balzer got up and gave a summary report of what those discussions were about. [Reference to slide #BB.1]

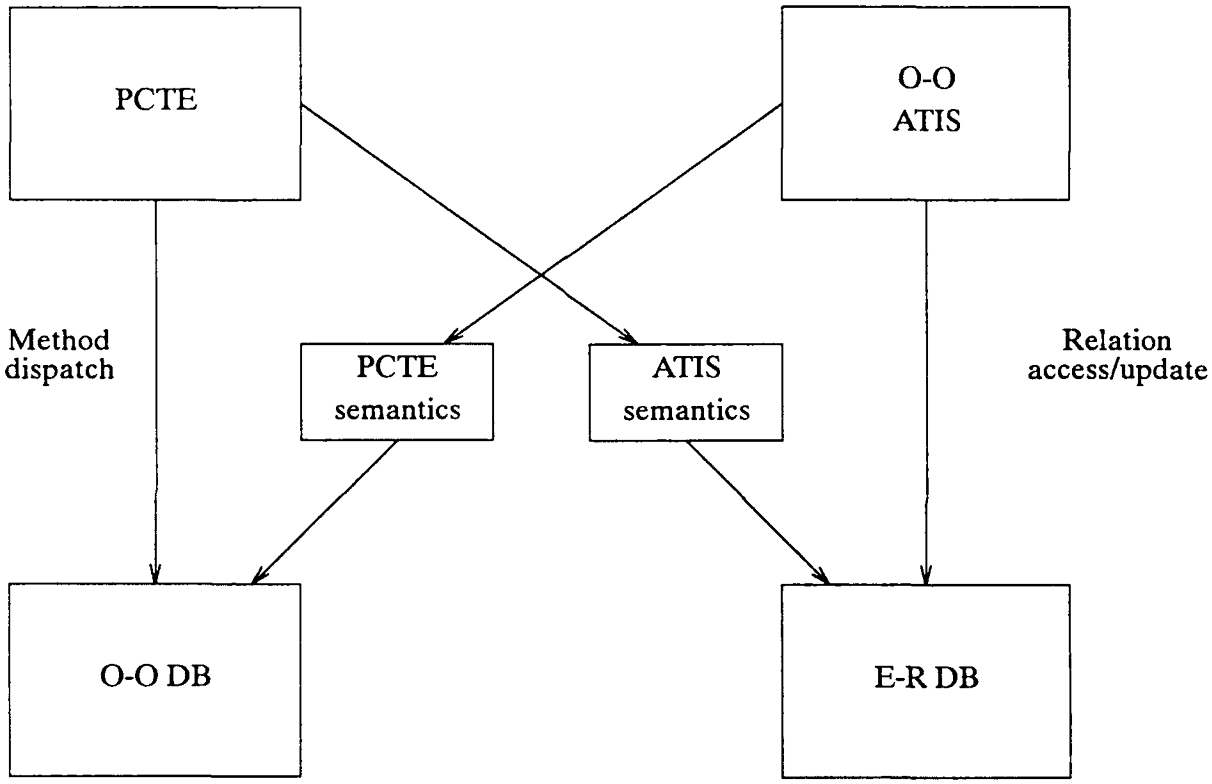
Basically those exercises dealt with what is involved if you want to provide interfaces that are accesses to a common repository; e.g., if the interfaces have different styles, and one style is object-oriented style and one is an ERA style. The first experiment was the one conducted by the DEC group in Italy. It amounted to building an object-oriented data base and constructing an ATIS set of interfaces and a PCTE set of interfaces (actually subsets of these). The PCTE interface implementation was in terms of method dispatches that were driven by the object-oriented data base. In order to do that, this underlying model required semantics that were not available in ATIS. So they put semantics from PCTE in the lower-level structure. Their strategy was to build something down at the bottom that has sufficient capability to serve the purposes of superior models, and, if necessary, add to this capability down here things that weren't present in either one.

Bob pointed out that another way to do it (which is not what they did) is to construct something down here [pointing to both "semantics" boxes] which was arbitrary (doesn't matter what it is) and there's a mapping between PCTE interfaces and ATIS interfaces as necessary. That's entirely a dual [interface solution].

Bill Hodges: Frank, can I help you a little bit there? This particular architecture for their experiment was the last of several attempts. They did choose to first try to put ATIS on top of PCTE and found some reasons why that was not acceptable and chose to go this route.

Frank Belz: So what they did first is something like this [pointing] which is the other way around; you start with something, for example, PCTE which is an ERA data model with its own capabilities, and you map ATIS functionality and PCTE functionality at this level. So that's what they tried and they didn't get to work.

DUAL INTERFACES



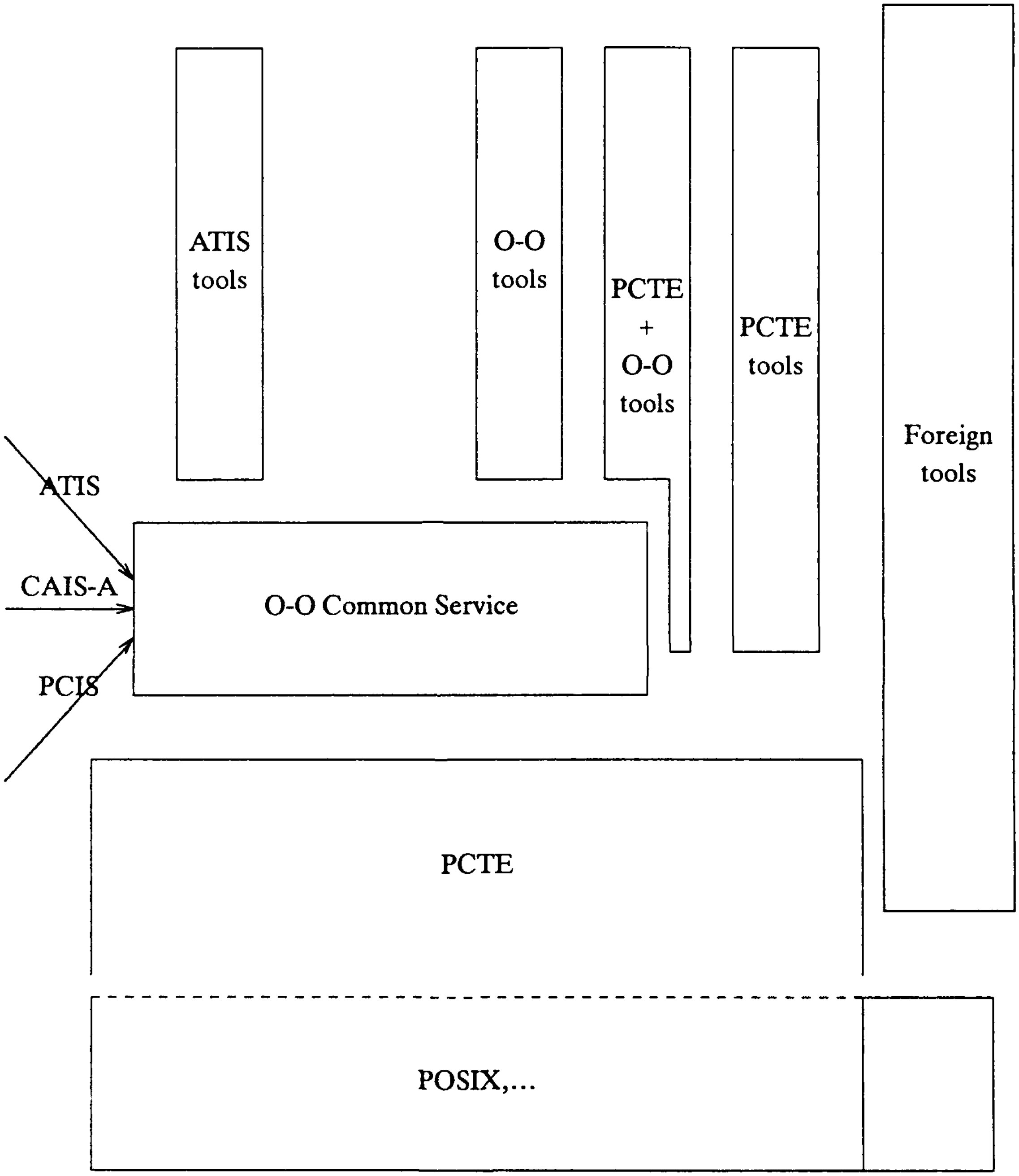
(BB.1: Foil drawn by R. Balzer)

At various times, several people in the community and in this group proposed a variation of this, with a strategy here which looked like this [reference to Slide RM.1] and I'm sure that everybody in this room has seen diagrams that look like this one time or another. There was a fair amount of discussion about this in which this is a variant of something which was discussed as the 'wedding cake' model, in which tools have access to various levels of the interfaces as necessary to be able to integrate them in the system at some level of integration. So *truly* foreign tools could reside on a visible POSIX interface, PCTE-only tools can reside on a PCTE interface, ATIS tools can reside on a set of common services (which is essentially the thing that the Italian team was unsuccessful at trying to achieve), and some tools might, in fact, require both object-oriented services and PCTE services; there was a lot of discussion about all of this.

The end result (and my conclusion is) that any of these strategies are strategies for evolving the mechanisms which allow you to use capabilities that depend on an object-oriented model or a PCTE model in the same environment over time. They don't necessarily imply that you are going to do any convergence exercise. But they do supply you with an evolutionary mechanism to implement functionality as part of the process. Now with regard to the difficulty associated with this, one of the points that was made can be easily illustrated with this diagram [slide RM.1].

It's all very nice to have tools stacked in this fashion, but if you want tools to interoperate, you haven't gone very far in achieving that in this stage of the game. Because in order to achieve that, you have to have some agreement, not only about what the bits are (that are going back and forth), what the control protocols are, but what those bits mean. And in order for that to occur, you have to have some common model which may be expressed in a class hierarchy in an object-oriented system, or may be expressed in a network of an ERA database. But you have to have some model of what it means to have that data and what the relationships are if any particular data in fact relate to any other data, you don't get that from this. That's another activity. That's another thing that has to happen. That which has to happen is (1) more difficult than any of this, and (2) is absolutely essential to occur, and activity should be conducted to see how that will proceed.

So Bob's way of classifying the issues is this: What I've just talked about is shared schema, i.e., at a logical level, you need to have an idea of what's happening in part of the environment of the tools that are depending upon the PCTE structure, ATIS structure, etc. You have to have shared logical schema which may be realized in different ways to serve as a basis for establishing interoperability.



(RM.1: Foil drawn by R. Minot)

Then there's the second issue which I'll call shared infrastructure. What is true about this system is that there are a lot of issues addressed in the PCTE system that are parameterized out of the current specification of ATIS. For example: the notion of process and transactions; the notion of security and access control mechanisms; the notions of view adoptions are different; concurrency control; differences between the models of versioning. So there are things which are either simply deferred in the ATIS community, or for which a different solution has been constructed to address these issues than is present in the PCTE community. So now the question is, how do you deal with this? Bob's hypothesis was that in the context of this evolutionary development capabilities, there were intermediate tactics that could be used to address some of these issues. I'm not going to go through all these tactics...

[some portions missing during tape change...]

[Note from Belz: the basic idea expressed in the missing transcript was: Bob's hypothesis that the shared infrastructure issues above could be addressed incrementally with tactical approaches was challenged by Ian's ...]

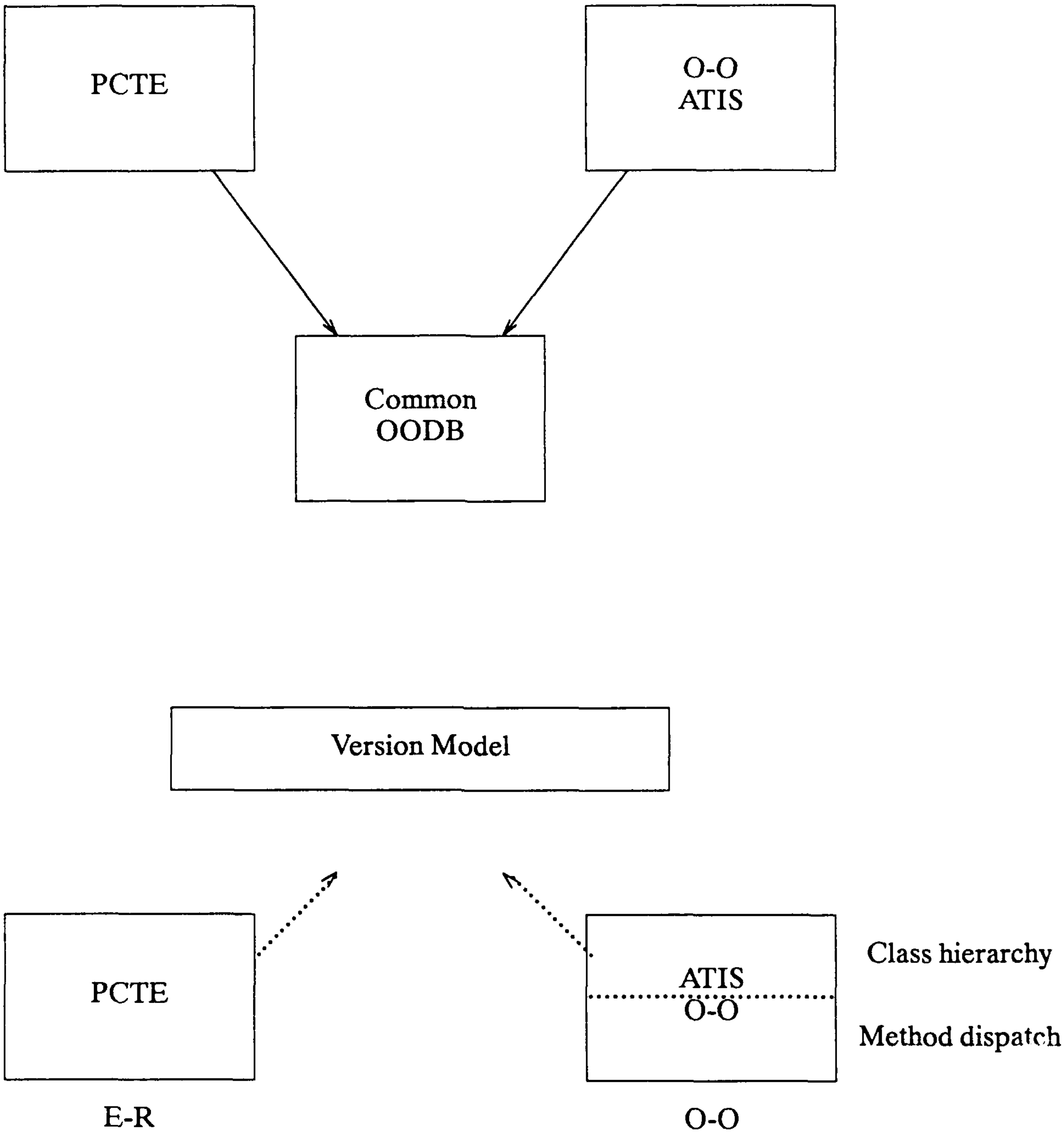
...position that these things aren't isolatable; they represent, in fact, a set of issues that have to be resolved by a significant engineering exercise, and that it's the interaction among all of these with the primary functionality that it has provided that determines the adequacy of the engineering exercises provided. And so the hypothesis was that this strategy may work in a limited way, but there is a discontir'uity: you can't get from here to something that's new and coherent and also convergent, without having a real shift in structure.

Jack Kramer: As a good example of that: you can't just take basically an arbitrary security mode! and arbitrary standard and expect them to work well together.

Frank Belz: Now that disagreement is completely unresolved at this point. The disagreement was stated; and you're going to see strategies for addressing it in the suggested actions, in the issues agreed upon, and in the issues not agreed upon.

Now on this slide [Slide AR.1], the upper part is representative of everything I have just discussed. The bottom is addressing in a more abstract way, what I just talked about with regard to how do you address issues like versioning, transactions, and things of that sort. Andy Rudmik has suggested that some of these were amenable to being addressed *independent of the underlying mechanisms*. So, for example, it may be that if you look at the versioning model over some exercise, you can come up with a way in which it makes sense abstractly to merge the notions of the versioning model that would be supported in something like a PCTE or something like an ATIS. Having that abstract characterization, you can define minimal maps for realization in these two systems. In those maps, you may achieve in terms of whatever versioning model that you support directly PCTE and it may be created by revising or extending or specializing classes that already exist in the ATIS class hierarchy. But the strategy basically was, work together with members of these communities; see if you can establish a target; and map that target back down into the mechanisms. By doing that, you wind up minimizing the distance. You also create pressure for these standards to fall into direct support for the kinds of things that we can agree to.

Now the second thing that is on this slide has to do with achieving low-level infrastructure support that makes it more possible to get that scenario to work, i.e., PCTE as a base technology. That has to do with the division in the ATIS world (or any object-oriented system) between (1) the basic mechanisms that are part of the kernel system – which principally involves



PCTE

O-O
ATIS

Common
OODB

Version Model

PCTE

E-R

ATIS
O-O

O-O

Class hierarchy

Method dispatch

(AR.1: Foil drawn by A. Rudmik)

method dispatching—and (2) the class hierarchy—which involves a lot of the decisions which the rest of the capabilities that you put on the tools are going to depend on, i.e., the common class hierarchy structures. Ian Thomas suggested that it was essential that you come up with the coherent working environment, to make sure that the method dispatching mechanisms provided in the object-oriented class were compatible with the binding of processes to data that were defined here [pointing to the "PCTE" box]. That is, the way in which you associate, instantiate, and execute processes or things of executable code over here [pointing to the "ATIS/O-O" box] has to be associated in some sensible way to the way in which you cause executable code to be executable over here [pointing to the "PCTE" box].

It turned out that four vendors at least were addressing exactly that issue from different points of view. The general agreement was that this was a fundamental question, and everybody who was really working hard on the problem was addressing it. The general problem was addressing that specific problem. Not necessarily in a common way: there are different ground rules for those who want PCTE to be a universal platform (asking how do you change the method of dispatch structure in ATIS so that's it's compatible with PCTE) from those who are interested in the ATIS world addressing the issue of what has to change in PCTE as well as what has to change in ATIS to get these things compatible. So it's a difference of commitment to, or not commitment to, preserving PCTE as it now stands.

Periodically during this whole discussion, there were questions of the form: "Have we narrowed our focus too much?" E.g., are we just looking at PCTE and ATIS when, in fact, there are other issues to be addressed? One of those might be CAIS; one of those might be the UNIX file system and special things built on it. Generally my assessment of the reaction to that was: "Maybe, but let's keep going." Basically how this group will react to that question is "Yes, we may be overconstraining the problem by the approach that we're taking, but we're doing fine, so let's keep going."

Oberndorf: I think it's fair to say that anytime you have PCTE up there on the slide (or talking about it), we could substitute PCIS and the operations would be similar.

Belz: There were various times where PCTE, and everything I just said, meant "what we've got in hand today." Most of the time, it [PCTE] meant "This is an abstraction for what PCTE evolves into as a consequence of Waltham/Winnersh, of PCIS, of whatever has happened or will happen.

Jack Kramer: PCIS is going to assume a PCTE basis... They're going to be driven because of political concerns and vested implementation issues. There will tend to be much more bias in the direction of PCTE, as opposed to being able to start anew, and be able to take something like ATIS and see how far you can push it... When we talk about what role STARS can play with respect to PCIS, you have to be realistic about the pressures that are going to be brought to bear with respect to PCIS, because of what the sponsor says.

Bob Munck: On the other hand, I think that if STARS makes progress on the object-oriented PCTE idea, PCIS will be free to go even further.

Belz: I don't think we're going to be living with some minor changes, but some compatible [missing words ...].

And *substantially* is not something that can be defined by the chairman of the cooperative group, it's defined by Vice-Presidents of companies, and that's one of the problems that you have. Certainly it would seem to me that the PCTE community as a whole would want to restrict changes to PCTE until it was clear that substantial movement [existed] for adopting PCTE as a vehicle for business and that's good. Because it leaves you with a sound foundation but it also exaggerates the effect: As you gain the basis for business you also gain a business inertia, a change inertia that gets greater. In any case, I think that for purposes of deliberations that we have had, that PCIS was very much a part of the thinking that was being addressed.

What I have described now took place from about noon yesterday until about noon today. What also happened was an attempt to try to focus on what strategies on convergence could be taken by STARS (or by anyone) that would help the process, given that it's pretty clear that people perceived it as a desirable thing. So one of the things we did toward the end of the day yesterday was do a brainstorming session. The nominal task of the brainstorming session was to come up with activities that would contribute to or constitute various strategies that would be taken. What got created is what you see on the wall.

What happened was that we could not restrict ourselves to that narrow a scope (which was fine...). What you see up there basically amounted to four major categories and one subcategory of brainstorming items:

1. Framework requirements
2. Technical approaches, including whether you want monolithic standards or whether

you want fragmented subset of standards

3. Frameworks standards development and management approaches
4. Some suggestions about the importance of defining the market place, i.e., "Who is it that is influenced by the convergence of these things, and how does that influence matter in the process that you take? "

So we constructed that list, and this morning we went through a voting process to determine which was most important. The process was everybody had 15 votes and could spend the maximum of 3 on any one issue. There were a lot of voters that voted for 5 items with 3 votes each.

The results of that brainstorming session were:

- *"OO on PCTE:"* a lot of people wanted to explore the issue about the relationship between object-oriented mechanisms and PCTE mechanisms, characterized by three of the issues (numbers 7, 13 and 15). Basically, they amount to variations of exploring that dialogue.
- *"Useful Union:"* there are several things that I think were most concisely expressed by Jack, which was "Find what the *minimum* necessary intersection is; then factor back in mechanisms to achieve the capabilities that are present already." So this is a strategy for achieving coherence in the design, while achieving functionality that's required. And a lot of people said that should be explored as a part of the process toward convergence. (NB: Number fifteen specifies something where O-O and PCTE are coexisting somewhere in the environment; it says not necessarily *on*, but *with*.)
- *"Know thy users:"*: If you look at 8, 10, 14, 21, and 37, it should be rather amusing:

  — Number 8 says: "exploit the fact that tool writers (not users) are the market place for convergence."

  — Number 10 says: "exploit the fact that the tool users are the marketplace and beneficiaries of such convergence."

  — Number 14 is the encompassing thing; it says: "figure out what's going on here; figure out what the project culture is, what's happening with tool development and figure out what that implies with regard to the requirements on the framework, and how that impacts convergence."

  — Number 21 says: "exploit the fact that the ultimate beneficiaries of convergence are the appliLations developers."

— Number 37 asks if and how O-O database vendors have a place in this whole process and result.

So the end result after having merged all that into 14 was that it received a pretty high vote.

- And then the other one is the issue we have already described, which is coming up with some approach to logical schema.

There were a number of other issues, some of which support those that are on this list. One that I personally want to point out is number 18: common interface below PCTE and ATIS.

[Discussion about whether the wording was accurate, because one version mentioned implementation, another mentioned interface.]

After we took the straw poll, we did not discuss it anymore; we came back and dealt with other issues. So this represents a *reading of this community*, but which was not explored nor refined nor addressed specifically. But it does represent an orthogonal reading on all the other activities that we were doing.

This morning we had two goals: one was to address the issue of what should be done in the long term (how should these issues be used; how should you evaluate these things in terms of the long term convergence process), versus how should we use these to guide our own activities in the short term? (This *[?convergence?]* was defined to be a long-term activity.) One conclusion is that many of these things did not have to do with strategy; and if you look at the things that *did* have to do with strategies, they are things that *have to do* with strategies but they're not strategies. [Puts up BB2.]

ALTERNATIVE CONVERGENCE GOALS

1. Single Standard

2. Interoperability

   Each operates in its own context,
   but dynamically share data

3. Encapsulated Batch Execution

4. Reduced Porting Cost

5. Independent But Compatible Standards ("Profilable")

   Subdivide monoliths into compatible pieces

6. Extended Standards To Reduce Distance

7. Several Complementary Standards

(BB.2: Foil drawn by R. Balzer)

So what Bob tried to do this morning was to say "OK, there *are* some strategies that could be discussed." (These were discussed, and no choices were made with regard to these, either. So that's another undecided that is not on the undecided list.) Among the ones that were discussed were, [pointing to BB2] first, a new aggregate monolithic single standard. Second, interoperability of the sort where the capabilities running on the object-oriented side and the capabilities running on the PCTE side dynamically share data. A restricted version of that [third item], where the sharing occurs only before and after the execution of units of activity. So there is a very batch-oriented flavor to the third option and a very interactive potential to the second option.

Then the fourth is an even weaker situation: what you have is various things added to the support of the capabilities so that they don't necessarily act together in a single environment, but for the tool writers, it's easier to generate tools that fit on both sides because you're reducing porting costs from various tactics you might take. (That's a strategic goal; in a sense, these are all strategic goals more than how to achieve them.)

Tricia added the wording "independent but compatible standards," which provoked a long and extensive discussion about what that might mean. We discussed the issue of profiles as they are now being used in the standardization world. I won't go into that. But one of them that is talked about is "What's the benefit of having a reference model (like the ISO reference model) as a way of subdividing the issues, and providing a set of standards that address issues that are characterized by subdivisions that are provided by the reference models?" That question was raised and no convergence was made.

Jack Kramer: [Something about "The ECMA Reference Model isn't sufficient for O-O systems..."]

*Frank Belz:*So the reason you see the NIST booklets out on the table is because there is an alternate object-oriented data base reference model that several people said that this is really terrific for describing O-O systems, and we're not sure that the ECMA model really covers the things as well in the O-O world as this does.

So some of you were here during the process when we tried to say now where are we and what have we concluded. So here's our shot at characterizing that.

The original consensus on the first agreement was that object oriented support is coming, and that is therefore a good reason why it is going to be provided and it better be supported. Actually what was said was it better be supported in *environments*, but what I wrote was that it better be supported in *frameworks*. In the end the group was willing to commit to this assertion (with the possible exception of Tricia who may yet articulate why that is a bad idea). The point here was, the emphasis on object-oriented technology is because it solves real software engineering problems; it's not just a technology fad.

The second thing was that we try to enumerate some of the things where we felt that, even if you didn't come up with a grand aggregate strategy structure, it would be useful to search for mechanisms for commonality. Those included: the schema, definitions of types and methods (with possible concern of granularity), versioning, transactions, distribution, data security, multiple use, multiple schema, multiple inheritance. All of those things were areas where it was felt there was some real work on addressing commonality that would be fruitful.

Then there is a sort of statement. (This list includes statements of fact about the universe, as well as things we came to agreement about.) One is that it became clear in this discussion, which it was not before, that of the two specs, one defining PCTE and one defining the ATIS, ATIS was in a much earlier stage of its evolution and was therefore more malleable and also more incomplete. The fourth agreement, that we just discussed, is the relationship between the PCIS activity and the evolution of PCTE. Related to these two things, you'll see some actions.

One of the observations that was made was that there really is no place in the standards activities community for addressing real framework issues: there's no home. The sixth agreement is about the commonality of schema or types and methods, which are viewed as important, very hard to achieve, and very important for STARS to begin addressing. The seventh agreement is that STARS should be working to assure that the kind of divergence that was perceived in the past doesn't get exaggerated in the process we go through; at the very least, convergence inhibiting further diversions ought to be an objective. (I think it was a much stronger actual agreement.)

The last two points of agreement were, in fact, in partial dispute: however, it was asserted that (in ATIS) you could separate the class hierarchy issue from the dispatch mechanism issue; that was there was value in doing that, and then addressing the relationship between the dispatch mechanism [?in both systems?]. In fact, at least the vendors that were here who are making investments in this area are exploring that strategy.

There were things that we left undecided, at least two of which we have just gone over that are not on this list. First, it was not decided, in the exploration of this commonality, how much resolution was necessary before you actually gained anything in terms of tool interoperability. It was not well understood by this group (in the span of two days) how far do you have to get in that process. There were really radically different assumptions—Balzer's assumption was that it was really fruitful to explore this because you would be getting incremental gains. And it was Ian Thomas' assumption that that was a debatable issue; it was not clear.

It was not decided whether or not to base this evolution on PCTE and view it as a matter of value added [to PCTE].

There was non-agreement about whether it was appropriate to base evolution on some version of UNIX, for example, a version of UNIX on which ATIS is built these days.

The fourth undecided point is an example of what the Object Management Group is doing in various exercises: Andy Rudmik several times suggested that it would be very fruitful to look at the successes in those communities with regard to interoperability, to see if there was anything to be learned from this arena. I think the fact that there was no agreement on this is more a reflection of the fact that we never really discussed it rather than there was some intrinsic source of disagreement.

We never discussed or agreed upon this issue of monolithic versus partitionable standards, and we never really got beyond this sort of enumeration of strategic goals. We never refined that, other than to define actions that could be taken to address these agreements or disagreements.

The actions that we could agree: the first point says it's a good idea and STARS should be involved in it. The second one says that there is some work to be done in regard to the unresolved issues, and some activity ought to be engaged to do that.

Action 3, the commonality search, amounted to a discussion that some work, on the order of the Waltham/Winnersh exercise that was done for CAIS/PCTE convergence, ought to be done for this convergence as well. This isn't a very refined suggestion with regard to which commonality issues need that kind of treatment. Re Note 1: I thought that we started that process at this meeting, but Tricia thought that the start was pretty darn small compared with what was necessary. Re Note 2: Bill said there's an urgency to this particular item: that something must get resolved before the June meeting, so you don't walk into the June meeting sending the wrong signals to the vendors.

This point [Action 4] addresses the issue of the fact that there's no home in the standards world for frameworks. Tricia mentioned that people are beginning to suggest homes that probably are inappropriate in structure of the standards community and that something may be done about this. It may be that the standards community is susceptible to some actions that would probably be appropriate to take.

Action 5, re Agreement 7, says that if the PCTE and ATIS communities are really separate, STARS should be exercising some influence in these communities.

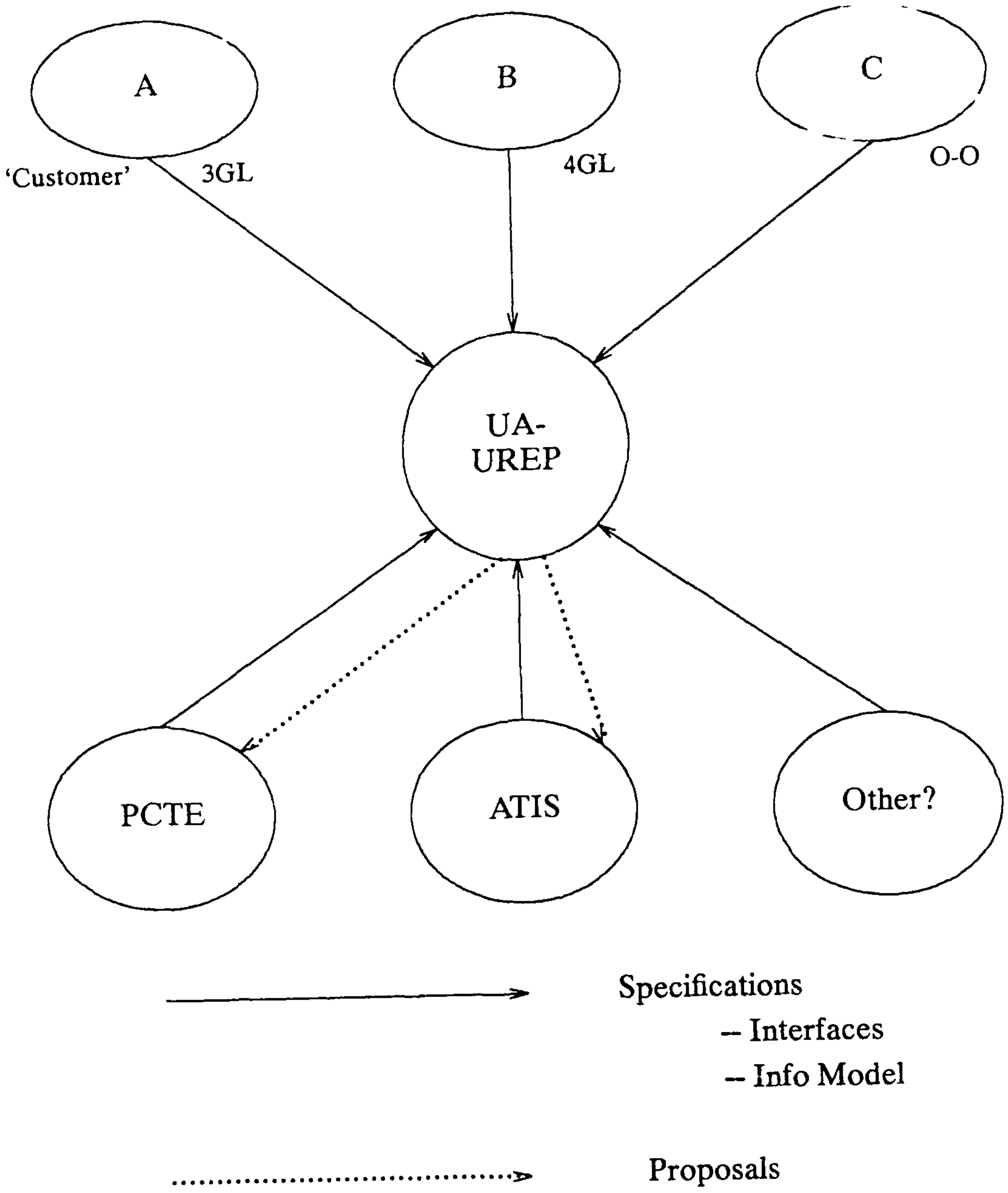
Action 6 addresses the issue of who's going to benefit by convergence; how should that benefit be exploited and used to guide the activity? As an example: the Unisys commercial people came with information about a strategy for doing that, and it became clear that there was an interaction between the Process work and the Environment work in this area. That potential interaction would be very beneficial if it were exploited and that was suggested.

Action 7 is specifically related to defining and exploiting the potential interaction with the PCIS process.

Teri, do you have any comments or questions? I think we had a very good discussion and information exchange. People's positions became much clearer and bases for their positions became much clearer. It generated a lot of ideas. We didn't do too much evaluating of these ideas and resolving them to concrete courses of action. Here's the territory, figure out what to do about them.

This is a very important slide [pointing to DG2]: I had it aside to pull it out and present it tonight, but I forgot.

PROJECT MODEL:



(Foil drawn by D. Goiffon)

I think that's the most important conclusion. An interesting additional conclusion is that as Unisys did this, one of their conclusions was they couldn't figure out how to define something like this that would adequately be supported by PCTE as it stands or by ATIS as it stands.

[discussion by David Goiffon of Unisys]

One of the issues that came up was whether the timing of the activities was sufficiently synchronized so that you could achieve what you'd like here. But it also may be true here that there are ways that subactivities can feed both into the Process work and the Environment work independently and synergize both. To assume, for example, that this information has to go through the Process group in order to have an impact on the Environment activity is inappropriate, I think.

OK, so that's the end.

APPENDIX D

MINUTES OF THE CONVERGENCE MEETING

These minutes were taken by Herman Fischer, and were edited by David Carney.

1. JOURNAL OF DAY 1, 22 Jan 1991

1.1 Welcome

Jack Kramer, director of the STARS Program, gave a brief welcome to the participants. He particularly noted that Barry Boehm, director of DARPA's ISTO Program, was very enthusiastic about the potential success of the meeting. Kramer noted that DARPA considers this meeting, and frameworks convergence in general, an important activity. Kramer pointed out the need in the STARS program for open architectures, standardized frameworks, and widespread commercial solutions for common Software Engineering Environment problems. He stated a need to be able to buy frameworks "off the shelf." Further, the STARS program will need to decide its chosen directions for open architecture and frameworks within the next nine months.

Kramer noted that the group represented a wide diversity of interests and investments. It may be that the search for Frameworks Convergence will begin as an academic exercise; but it will soon become important to address it as a wider problem for software engineering in general: how do we compose tools as opposed to merely invoking them.

Kramer also noted the current progress of PCTE in becoming an accredited standard. He felt that this represents a significant event, though he also noted how long it has taken to arrive at this point. He then summarized his particular concern, and the major point (for STARS) of the meeting. If one compares an Entity-Relational model (such as PCTE or CAIS-A), with an Object-Oriented one (such as ATIS), there are obvious differences between them, and between the commercial forces that are working with them. If these two models evolve or progress in divergent directions, this could be catastrophic for any DoD hopes for standardized commercial frameworks and environments.

1.2 Capsule Presentations

Belz then requested that some of the participants present capsule overviews of some representative programs in the Frameworks arena.

Presenters:

- Regis Minot, PCTE, Emeraude, ECMA
- Herm Fischer, PCTE, EAST, Emeraude, Sematech
- Gary Pritchett, CAIS-A Program Status
- Currie Colket, Brief comments on PCIS

- Tricia Oberndorf, NCGR/PSESWG

Two other participants also gave brief presentations. Andy Rudmik, of the CIS Consortium, commented on several items needed for systems engineering: class models (e.g., what CIS is developing), declarative models, and system administration of tailoring and integrating functions. He also addressed the fact that technologies to support process modeling are weak.

Hugh Beyer gave an overview of ATIS:

ATIS is a [proposed] standard based on the Atherton Backplane, with UNIX dependencies removed. The document is a proposed base standard for IRDS-2. The goal {of ATIS] is to have the repository cover the entire life cycle from enterprise modeling, conceptual modeling, process modeling, application design, project management, maintenance, reengineering, etc. ATIS models can describe: (a) base objects, (b) versioning, (c) configuration management, (d) tool integration, (e) work flow control (where you are in the life cycle in a process), (f) IRDS concepts.

Beyer feels that the Repository *has to be Object-Oriented*. He described the DEC facility in Varese, Italy, which is a PCTE site, and which has been investigating a merger of PCTE and ATIS. They built an underlying O-O object base, then built ATIS and PCTE on top so that constraints were implemented by methods. PCTE stability links were used to build ATIS constraints. There were still cases where the PCTE side users could see more than the ATIS side users could. The experiment proved that PCTE and ATIS could share the same object base. Beyer noted that they weren't addressing schema-level mergers.

Other points of Beyer's presentation:

— DEC has produced a comparison of standards using ATIS as a reference model

— ATIS represents RELATION as a specific type, which allows PDES to represent relationships directly in ATIS models (Beyer noted that this is a controversial topic in CIS).

Frank Belz:

We've completed a review of the framework initiatives which are available to converge. Next we'll look at alternate solutions and see how they might be complementary or conflicting, followed by technical approaches to convergence. We will then try to identify technical resolutions on achieving convergence.

One problem is that many organizations are solving the problem in almost the same context: PCTE, EIS, CAIS, et al. Because of the different people involved, you get different solutions (which first look like design inconsistencies). STARS' dilemma is to identify whether there is an issue of CAIS vs PCTE vs ATIS, or whether there is technical territory where these do not differ.

We will address:

a. merging standards (at the interface level, at the schema level)
b. synergistic coexistence (of existing standards)

Beyer: Regarding a PCTE and ATIS merger: You do *not* want an O-O interface on top and PCTE below. In such a situation [when DEC tried it], PCTE ignored the constraints in the semantics of the O-O database. Instead, you want to share the useful part of the framework. IBM, DEC, Pansophic have taken approach of using standard database below O-O, and eliminating access to the lower level database.

DEC did build an underlying O-O object base (understanding methods and objects), and then on top of that built an ECMA PCTE object base and some of the ATIS interfaces. When you dispatch a method or define an object on the ATIS side, it turns into a method dispatch in the underlying object system. All the semantics are in the shared part (the underlying object base). PCTE is not exclusively object-oriented, so its operations need to be translated into equivalent object method dispatches (e.g., get state, return this link property, etc.). You end up with one unified schema: you have two interfaces to same object base, but different versioning models, etc, that need to be unified.

Fischer: noted that a tool-level schema would have to be specifically implemented on both the ATIS and PCTE sides to be convertible, so that they could have this translation.

Thomas: ATIS defines some object types and methods, PCTE also defines object types. But what is the relationship between objects? If it is disjoint, you can't use tools on both sides predictably. You could, however, map both sides to a simpler underlying set.

Beyer: DEC extended [PCTE's] Schema Definition Sets to include specifying methods on PCTE's side.

Rudmik: Questioned whether you could define classes in a bottom layer which could specialize to ATIS and be common to PCTE. If the classes for the two are substantially divergent, the models are different.

Beyer: Many potential users want common type definitions, and then you can model both frameworks together.

Balzer: The question is on how much agreement is there on the things in the repository and in the support structure. How critical are the adopted versioning models?

Fischer: If you don't agree on the versioning model, you may agree on tool level schema. [But] the set of assumptions on the data have to be weaker.

Kramer: Got "a knot in stomach" for this reason: CAIS decided NOT to discuss the particulars of configuration management. Making decisions on a particular order gives process decisions; the environment should have flexibility in this area precisely to avoid "one versioning model."

Belz: The mechanism of how tool-constructing functionality is given may be incompatible (discussion after class type hierarchy order).

Balzer: We've had one proposal for convergence (the DEC approach) based on translating interfaces. That's a feasible approach at the interface level. What's important is: what else do you need for interoperability to make sense (shared schema, etc)? We need a synergistic coexistence (like an underlying OODB). Why shouldn't it be possible to take a PCTE schema, augmented with methods on it, or an ATIS, and state declaratively things already true but implicit? This doesn't change tools, but changes the information already known by any tool looking at Metadata (schema). Both ATIS and PCTE felt walking the data structures is important; but adding declarative specifications is not incompatible existence. The issue is that there is an opportunity to merge the advantages of the two approaches.

Fischer: Suggests adding time-based constraints.

Balzer: That wo ıld be on the fringe of what we could do.

Kramer: Reflects a fear of O-O items: the ability to see "inside" the methods in an easily communicated way. O-O approaches fall back into trap of needing to see inside code.

Fischer: Noted that you need the source code of superclasses to see how they behave at lower levels.

1.3 Brainstorming Session

In order to draw forth a list of key issues, Belz then suggested using a structured method of "brainstorming". The technique had the following rules: first, each participant would have the opportunity to state any chosen critical issue. The issue would be recorded without debate, and there was no limit on the number of issues that any individual wished to raise. Following the issue-raising period, there would be a structured vote on the total list of issues. The intention was to isolate the items or areas that were of general concern. Oberndorf noted that since the technique permitted issues to be of any scope, the voting would very likely require "comparing apples and oranges." Belz replied that this was, in fact, not a bad thing: the nature of the problem was such that such comparisons were often necessary.

The following list is a reproduction of the items as they were recorded during the brainstorming session.

1. *Design single common superset of systems.*
2. *Need independent standards organization to drive convergence.*
3. *Need to develop independent common external form (how we exchange data with environments through neutral form).*
4. *Include schema definition in the process of convergence.*
5. *Fundamental difference in paradigms (OO vs ER) mean that we have to investigate interoperability mechanisms.*
6. *Still do-able to find common schema for these two systems.*
7. *Given that PCTE is standardized and ATIS needs lots added, given PCTE interface, come up with new OO view from scratch with PCTE in mind (instead of OO view with UNIX in mind like CIS is).*
8. *Framework convergence has a market for toolwriters, and that's all; tool users don't care about framework convergence. Marketplace is toolwriters. (Frank wrote down: exploit the fact that tool-writers (not users) are the marketplace for (beneficiaries of) convergence.)*
9. *We should converge frameworks by defining the useful union of CAIS, PCTE, ATIS, and any other frameworks we find. Jack defined useful union by taking the*

intersection (Venn diagram) and adding in rest of features.

10. *Real value of technology is ??? should do more to exploit what we are trying to accomplish. (Frank wrote: Exploit the fact that tool-users are the marketplace for (beneficiaries of) convergence.)*
11. *Worried about giant big frameworks we can't implement. Go back to UNIX file system and add to it the things we need to achieve our goals. Type structure, multi-inheritance, object orientation. Wants minimum, smallest system.*
12. *Goal should be single standard, not two standards with side doors for tools to go through. Superset system should not have sub-standards.*
13. *Design as a common service on top of ECMA PCTE an OO layer satisfying object oriented requirements identified for these systems (in particular ATIS and PCIS).*
14. *We're all here as providers [of tools] and are qualified to define software project cultures and derive qualitative requirements illustrating the end usage of what we are trying to standardize.*
15. *(Similar to 7 & 13) develop OOISS (Object-Oriented Interface Support Services) on top of PCTE which (a) complements PCTE and (b) has no unnecessary changes to ATIS.*
16. *Don't. [sic]*
17. *Identify the layerings of our environments. Don't develop one monolithic standard.*
18. *Call the bluff of the ATIS people who say they see a converging path; lay out the technical steps necessary and see if that is feasible. Explore the proposed "dual interface" to an underlying implementation for PCTE and ATIS (Hugh's model) in terms of the technical areas that it must address to determine feasibility.*
19. *Identify a common acceptable reference model for verification and implementation of the framework convergence.*
20. *Standardize disagreement. Take advantage of cases where we can agree on an approach but can't agree that it's worth pursuing. For example, ATIS doesn't have mult inheritance; say "if you were doing multi inher. you would do it this way".*
21. *Corollary to 8. Exploit concept that ultimate benefactors of converged environment are application developers.*
22. *Target convergence in the software engineering workproduct and process models*
23. *Design as a common service on top of CAIS-A an OO layer satisfying object oriented requirements identified for these systems (in particular ATIS and PCIS).*
24. *Assure that framework be useful for small as well as large systems (for example MCCR applications and AIS products).*
25. *Take PCTE and ATIS, break them into component parts or layers, before we consider merging. Then we take the pieces and shuffle them into the converged output product.*

26. *Define levels of framework extensions: minimum subset, superset, and extensions in between.*
27. *Include ATIS in a detailed comparison in the style of the Winnerish Report.*
28. *Drive convergence with assumption that we will have heterogeneous frameworks for a while (assumes they have to interoperate).*
29. *Build supersets of existing standards. Start with merging of declarative, ER, and imperative OO models.*
30. *Allow incompatible extensions to the various input standards when we do the convergence.*
31. *Define the timeframe within which we expect results.*
32. *Framework must be elegant, simple. affordable, efficient, and commercially marketable. Define market size before designing.*
33. *Take advantage by leveraging existing standards such as OSF, SQL, Motif, X Windows.*
34. *Framework is more than the object manager. Should have an object manager which defines as objects all the things of the framework, (widgets, windows, etc). To handle complexity you'd need subschema.*
35. *You should encourage tools to go back to the UNIX "small is beautiful" religion; a tool should do one job. A tool should not do internal versioning, transactions, and other things which other tools do.*
36. *Support migration and encapsulation of existing tools.*
37. *Understand if and how OODB vendors have a place in this brave new world.*
38. *Define the role that the PC will play in the frameworks of the future (including Next and super-PCs which will be almost in the home).*
39. *Attach high priority to the distribution architecture requirements.*
40. *Design to accomodate multiple changing underlying OSes and comparable services.*
41. *Be able to encapsulate different frameworks.*
42. *Encapsulate toolsets (in addition to individual tools).*
43. *Lowest level of standard should be an OO NFS.*
44. *Don't feel compelled to take various standards in entirety but take meaningful necessary subset.*
45. *Defer distribution architecture to lower level services.*

The list was then examined in two ways. First, the issues were discussed to see if any general categories emerged. The following categories were suggested:

- Framework Requirements
- Standards (including supersetting and subsetting strategies)
- Framework Standards Development: Technical approach

- Target Markets
- Framework Standards Development: Management approach

NB: As the issues were categorized, the participants noted that these categories were not a true partition of the issues, and thus that it was possible for an issue to be a member of more than one category.

Following this step, issues that were deemed to be similar were aggregated. The degree of similarity was variable, but some collapse of the large list was felt to be necessary. (In fact, one of the aggregations collapsed statements that were precisely contradictory. The rationale for this was that, whether one chose the negative or positive view, the statements referred to the same issue.)

The following table lists the issues in the chosen categories.

Category	*Issue number*	*Topic*
Framework Requirements:		
	3	Common External Form
	4,6	{aggregated as} Common Schema
	11	Back to Unix
	12	Goal is a single standard
	17	Identify layering of environments
	19	Identify common Reference Model
	24	Goal is small as well as large systems
	28	Assume heterogeneous frameworks
	32	Goal is elegance, simplicity,...
	33	Leverage existing standards
	34	Define Framework as more than Object Manager
	35	Small is beautiful
	36	Support tool migration and encapsulation
	38	Define role of PC
	39	High priority to distribution requirements
	40	Design to accomodate underlying change
	41	Design to encapsulate different frameworks
	42	Encapsulate toolsets

43	Lowest level should be an O-O NFS
44	Take meaningful subset of standards
45	Defer distribution architecture issue

Standards (including supersetting and subsetting strategies):

1	Design single common superset
26	Define framework extensions

Framework Standards Development (Technical Approach):

5	Investigate interoperability mechanisms
4,6	{aggregated as} Common Schema
7,13,15	{aggregated as} O-O on top of PCTE
9,44	{aggregated as} Useful union of CAIS,PCTE, and ATIS
11	Back to Unix
18	Common interface below PCTE and ATIS
20	Standardize disagreement
23	Design O-O layer on top of CAIS-A
25	Restart from ATIS and PCTE components
27	Need for a Winnersh-style ATIS report
29	Build supersets from existing standards
30	Allow incompatible extensions
43	Lowest level should be an O-O NFS

Target Markets:

8,10,14,21,37	Know the market/users of frameworks

Framework Standards Development (Management Approach):

2	Standards organizations drive convergence
14	Who are we trying to satisfy
16	Don't
22	Focus on workproduct and process models
31	Define convergence timeframe
33	Leverage existing standards

2. JOURNAL OF DAY 2, 23 Jan 1991

2.1 Summary Presentation: Bob Balzer

At the start of the second day, Balzer gave a summary presentation on possible ways to foster convergence. One key question is: What do we mean by convergence? Balzer suggested some possible answers. Convergence might mean:

- a single standard
- interoperability, where each operates in its own context, but dynamically shares data (interactions between tool and framework while it is operating) (selectively shared semantics where tools require semantics on both)
- encapsulated batch execution (foreign tools concept) (can spawn ATIS tool in PCTE and import its data when done)
- reduced porting cost (assume multiple frameworks in environment, reduce cost of getting same tool to work in both environments)

During the following discussion, three other possible meanings for convergence were noted:

- independent, but compatible standards (cf. the discussion of 'Profiling'). This could mean subdividing monolithic standards into compatible pieces, thus making the standards 'profilable'.
- extended standards, thus reducing the distance separating them
- complementary standards

Kramer: Wants an idea of what directions STARS can consider by end of the day. Jack wants the group to clarify the appropriate goals for STARS, and the appropriate steps STARS should take. What are the criteria (technical & pragmatic) by which STARS will make its selection?

2.2 Profiling Of Standards

Oberndorf gave a brief presentation on 'profiling', as defined in other similar activities such as the POSIX ".0" group. One key notion in such activities is organizing a higher level issue of profiles, which is, essentially, picking a thread of capabilities from a set of standards. Said differently, a profile is a way of relating a set of standards aggregated together. Thus, an aggregate of standards for an OS, networking, data mangement, and data interchange definitions of a computer-based information system would be a profile.

As an example: assume one is putting together a specification for some system. Key questions might be: is it distributed or not; is it a banking system; does it need this special capability which has no standard yet; (e.g., for every capability you need a standard, is there one which matches); etc.

STARS is seeking a *category* of profiles, a world of technological capabilities. One critical issue is that, when looking at suites of standards, one can't pick two simply off the shelf because they may have underlying incompatiblities.

Thomas: Gave a picture of standards selection with OSI protocol stack, 3 at top layer, 2 next layer down, 2 bottom layer. Given that picking any choice at one level implies constraints at the lower levels, then with ATIS and PCTE, if you have object managers, process managers, etc., it is extremely hard to identify the lower chunks and determine the constraints to take lower chunks and mix and match from PCTE and ATIS.

Fischer: Note that the sub-chunks of ATIS and PCTE are all highly cohesive and not separable, and couldn't be recombined.

Kramer: Note that reworking a tool from ATIS to PCTE involved reworking interfaces (easy), data models (harder), and control models (impossible).

Balzer: spoke of 'Dual Interfaces:' The Varese DEC model dispatched methods under PCTE to use the same OODB as ATIS. Concerns not addressed are:

(1) Shared schema (or highly inter-mappable)
(2) Shared meta model
    (a) Transactions
    (b) Versioning
    (c) Security

You could then add PCTE semantics to the line between the ATIS implementation layer and the underlying OODB layer. Alternatively you could reimplement what DEC did at Varese and implement ATIS on an E-R database and add ATIS semantics to the line from ATIS to the ER database.

Kramer: STARS needs to use existing commercially supported standards. The STARS Primes could use different choices of standards as long as there was a possibility of merging or migrating the standards to each other. STARS would play a role in driving this convergence. (The preferred alternative is for STARS to select a single standard.)

2.3 Frank Belz's Review Of The Meeting

Called it "Convergence of OUR Process:" First, made small clarifications of strategies/programs were helping there, and that the STARS primes were working with their commercial affiliates to do the same thing. From the SEI process work, STARS will both push them into the process and learn from what they are doing.

In the next hour, we must come to concurrence about what we have concurrence on.

2.4 Voting On 'Brainstorming' Issues

Votes were taken on the "brainstorm topics" to determine the most important issues in the topic of convergence. Each attendee was given 15 votes to distribute among the forty-four issues. Any issue could receive up to three votes; thus each participant would need to vote for at least five of the issues. A vote for any member of an aggregate issue was regarded as a vote for the entire aggregate.

These were the results:

Most Significant Topics

Item number(s)	Topic	Vote Count
7,13,15	OO on top of PCTE	37
1,9,29,44	Useful Union	28
10,14,37	Know thy users	26
4,6	Schema	24
17	Layering environments	17
18	Common I/F below ATIS & PCTE	14
13	Standards organizations drive convergence	13
11	Back to Unix	12
27	Winerish-style ATIS report	12
28	Heterogeneous frameworks	12
32	Boy-scout motto	11
35	Small is beautiful	11
3	Restart from ATIS&PCTE components	11
25	Independent common external form	10

Remaining Topics

Item Number	*Topic*	Vote Count
5	Investigate interoperability mechanisms	8
19	Identify common Reference Model	8
38	Define role of PC	7
23	Design OO layer on CAIS-A	6
24	Goal is small as well as large systems	6
26	Define framework extensions	6
34	Define framework as more than object manager	6
36	Support tool migration & encapsulation	6
39	High priority to distribution requirements	4
40	Design to accomodate underlying change	4
12	Goal is a single standard	3
31	Define convergence timeframe	3
30	Allow incompatible extensions	2
33	Leverage existing standards	2
43	Lowest level should be OO NFS	2
16	Don't	1
20	Standardize disagreement	1
41	Ability to encapsulate different frameworks	0
22	Focus on workproduct & process models	0
42	Encapsulate toolsets	0

The following tables expand these results, showing the exact wording of all aggregate issues, for the most significant items.

OO sur PCTE *{7,13,15: first place with 37 votes}*

7 Given that PCTE is standardized and ATIS needs lots added, given PCTE interface, come up with new OO view from scratch with PCTE in mind (instead of OO view with UNIX in mind like CIS is).

13 Design as a common service on top of ECMA PCTE an OO layer satisfying object oriented requirements identified for these systems (in particular ATIS and PCIS).

15 Develop OOISS (Object Oriented Interface Support Services) on top of PCTE which (a) complements PCTE and (b) has no unnecessary changes to ATIS.

Useful Union *{1,9,29,44: second place with 28 votes}*

1 Design single common superset of systems.

9 We should converge frameworks by defining the useful union of CAIS, PCTE, ATIS, and any other frameworks we find. Jack defined useful union by taking the intersection (Venn diagram) and adding in rest of features.

29 Build supersets of existing standards. Start with merging of declarative, ER, and imperative OO models.

44 Don't feel compelled to take various standards in entirety but take meaningful necessary subset.

Know thy users *{10,14,37: third place with 26 votes}*

10 Real value of technology is ??? should do more to exploit what we are trying to accomplish. (Frank wrote: Exploit the fact that tool-users are the marketplace for (beneficiaries of) convergence.)

14 We're all here as providers [of tools] and are qualified to define software project cultures and derive qualitative requirements illustrating the end usage of what we are trying to standardize. Resolve: Who are we trying to satisfy

37 Understand if and how OO DB vendors have a place in this brave new world.

Schema *{4,6: fourth place with 24 votes}*

4 Include schema definition in the process of convergence.

6 Still doable to find common schema for these two systems.

Layering environments *{4,6: fifth place with 17 votes}*

17 Identify the layerings of our environments. Don't develop one monolithic standard.

Common Interface below ATIS & PCTE *{18: sixth place with 14 votes}*

18 Call the bluff of the ATIS people who say they see a converging path; lay out the technical steps necessary and see if that is feasible. Explore the proposed "dual interface" to an underlying implementation for PCTE and ATIS (Hugh's model) in terms of the technical areas that it must address to determine feasibility.

OTHER ITEMS FROM THE VOTING:

Standards organizations drive convergence.

Back to UNIX.

Include ATIS in a detailed comparison in the style of the Winnerish Report.

Drive convergence with assumption that we will have heterogeneous frameworks for a while (assumes they have to interoperate).

Framework must be elegant, simple, affordable, efficient, and commercially marketable. Define market size before designing.

You should encourage tools to go back to the UNIX "small is beautiful" religion; a tool should do one job. A tool should not do internal versioning, transactions, and other things which other tools do.

Take PCTE and ATIS, break them into component parts or layers, before we consider merging. Then we take the pieces and shuffle them into the converged output product.

Need to develop independent common external form (how we exchange data with environments through neutral form).

APPENDIX E

DOCUMENTS REFERENCED AT THE MEETING

Some of these documents were distributed either before or during the meeting.

1. **Contribution by Dr. John Nissen, GEC Marconi Software.**

   There is no indication on this document of its date or source of publication, nor the nature of the occasion for this "contribution.".

2. **PCTE - ATIS Common Environment: A/D.** Fabio Bagatin, SDT Italy, NASHUA, October 7, 1990.

   A set of forty briefing slides. The reference to Nashua is a reference to DEC.

3. **Object Database Management Systems: Concepts and Features.** Christopher E. Dabrowski, Elizabeth N. Fong, and Deyuan Yang. NIST Special Publication 500-179, April 1990.

   This document was discussed and distributed during the meeting and was incorrectly assumed to be a Reference Model for Object-Oriented environments.

4. **A Reference Model for Computer Assisted Software Engineering Environment Frameworks.** Anthony Earl, Hewlett Packard, August 17, 1990.

   This document is the ECMA Reference Model, which has also been accepted in large part by the NIST ISEE Working Group.

5. **CASE Integration Service: Technical Description.** Chris J. Nolan, Digital Equipment S.p.A., Varese, Italy, March 31, 1990.

6. **Introduction to CAIS: Common Ada Programming Support Environment (APSE) Interface Set (MIL-STD-1838A).** C. Hitchon et. al., September 30, 1989.

7. **A Comparison Analysis of Repository Approaches.** Hugh R. Beyer, Kathy Chapman,and Chris Nolan. September 17, 1990.

8. **Software Technology for Adaptable, Reliable Systems (STARS): Task BS25: Object Manager Technology Framework Specification Comparison.** The Boeing Company, January 4, 1991.

9. **Enterprise II: L'Environment de genie logiciel.** November 26, 1990.

   This paper was brought by Regis Minot, and refers to an environment constructed using a basis of Emeraude PCTE.

10. **Emeraude: A Production Quality Implementation of PCTE.** GIE Emeraude, 1990.

    Two sets of briefing slides. The first twenty slides are particular to the Emeraude implementation of PCTE; the remainder of the slides describe **Enterprise II** *(cf. # 10) and* **EAST**.

11. **Corrigienda and Addendum to Papers for International Workshop on UNIX-Based Software Development Environments.** Several papers by various authors.

    Numerous papers and topics; several are descriptions of aspects of the Japanese SIGMA project.

12. **Comparison of CAIS-A and PCTE+** June 1988, Ada Joint Program Office, U.S Department of Defense, and the Independent European Programme Group, Technical Area 13.

    This is the "Waltham Report" that examined technical differences between CAIS-A and PCTE+, both of which are ERA interface sets.

13. **PCTE+ and CAIS-A Convergence** November 1989, Ada Joint Program Office, U.S. Department of Defense, and the Independent European Programme Group, Technical Area 13.

    This is the "Winnersh Report" that concluded that convergence between CAIS-A and PCTE+ was feasible. The result of this report was the creation of the PCIS initiative which is currently in the process of determining requirements.

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